STATUS OF MINERAL RESOURCE INFORMATION FOR THE FLATHEAD INDIAN RESERVATION, MONTANA

By

M. R. Mudge
J. E. Harrison
M. D. Kleinkopf
U.S. Geological Survey

R. G. Ingersoll, Jr.
U.S. Bureau of Mines

Administrative Report BIA-22
1976

CONTENTS

SUMMARY AND CONCLUSIONS

Mineral resources of value or potential value in the Flathead Indian Reservation include gold, silver, copper, lead, platinum, palladium, building and ornamental stone, clay, and sand and gravel. The energy resources may include geothermal areas and an unknown uranium potential.

Copper is the principal metal recovered from the Flathead Indian Reservation deposits. Silver, gold, lead, and platinum-palladium were also recovered. Most mineralized areas are along and near contact zones between diorite-gabbro intrusives and argillite and quartzite. Ore has been shipped from the Revais Creek, Camas Prairie, and Seepay Creek mining districts located in the southwest corner of the reservation. No production is recorded for those parts of the Elmo and Hog Heaven districts that are on reservation land, but the Elmo district has many lead-zinc mineral occurrences.

Geologic, geophysical, and geochemical studies are recommended for the western and southern parts of the reservation in areas containing positive magnetic anomalies. The studies should determine the presence, if any, of buried but near surface igneous masses and possible related ore mineralization.

Other recommendations include one or more similar studies in areas of potential metalliferous veins, placer gold, copper-bearing strata in the Empire Formation, clay, sand and gravel, geothermal energy, and possibly uranium.

INTRODUCTION

General

This report was prepared for the Bureau of Indian Affairs by the U.S. Geological Survey and the U.S. Bureau of Mines under an agreement to compile and summarize available information on the geology, mineral resources, and potential for economic development of certain Indian lands. Source material included published and unpublished data, as well as personal communications. In addition, resource computer files of the Geological Survey and Bureau of Mines were searched for reference to specific mineral deposits in the reservation. There was no field work.

The Flathead Indian Reservation includes parts of Lake, Sanders, Missoula, and Flathead Counties in northwestern Montana (Figure 1). The original reservation totaled 1,242,969 acres of forest, range, and agricultural land. Through years of homesteading and allotment sales to non-Indians, the Indians' share of the reservation has been reduced to 616,726 acres (BIA personal commun). Of this total, the Confederated Salish and Kootenai Tribes own 564,733 acres. The balance, except for 1,017 acres in government reserve, is allotted land held by individual tribal members (Figure 2).

The reservation is approximately 50 miles long in a north-south direction and 40 miles at its widest east-west dimension. It contains the centrally located Mission Valley which is surrounded on the eastern, western, and southern sides by mountain ranges (Figure 1). The gently rolling hills of the Mission Valley have been modified by Glacial Lake Missoula and subsequent glacial activity. The valley ranges in altitude from 2,480 feet to nearly 5,000 feet. Altitudes of the low mountains which form the western boundary reach almost 6,400 feet, the higher mountains to the south rise to nearly 7,800 feet, and the Mission Range on the eastern boundary reaches 9,800 feet.

The Flathead Reservation is easily accessible, with U.S. Highway 93 paralleling the Mission Range, and U.S. Highway 10A crossing its southern end. Numerous state, county, and logging roads supplement the highway system. The more rugged mountain regions are inaccessible to most motorized vehicles. The Burlington-Northern railroad services the southern and eastern areas.

The southern half of Flathead Lake is in the northeastern corner of the reservation. The Flathead River flows south and west from Flathead Lake and exits in the southwestern corner of the reservation. Virtually all streams within the reservation are tributaries of the Flathead River.

The principal settlements in the area are Polson, Ronan, and Pablo located along U.S. Highway 93. The largest nearby cities are Missoula, south of the reservation, and Kalispell north of it. Tribal headquarters are at Dixon. Population in 1971 was 2,833.

The reservation's climate is moderate compared to the rest of Montana. The average minimum temperature for the coldest month is 18ºF, and the average maximum for the hottest is 86ºF, but extremes can range from -30ºF to over 100ºF. Total annual precipitation averages 15 inches which includes a normal 67 inches of snow per year in the valley, with much greater accumulations in the higher mountains.

In Mission Valley, farming and grazing are major agricultural industries. The heavily forested mountain slopes provide timber for a wood--products industry.

Map Coverage

The Flathead Indian Reservation is covered by topographic maps in the U.S. Geological Survey's 7 ½- or 15-minute quadrangle series (Figure 3).

Acknowledgments

Personnel from national and state government agencies and from private industry who helped provide data for this report include: S. L. Groff, Willis Johns, and Don Lawson, Montana Bureau of Mines and Geology; Gordon Brox, Fred Skrastin, and Jack McCoy, the Anaconda Company; John Trammell, Oklahoma State University; Earl Elstone, Spokane; Charles Flynn, Helena; Bob Newman and Cynthia Embretson, Bureau of Land Management; Art Sampson, Bureau of Indian Affairs; George Mowat, U.S. Geological Survey; and Johnny Newman, Confederated Salish and Kootenai Tribes.

Previous Work

Five administrative reports of the Montana Bureau of Mines and Geology discuss mineral exploration in parts of the reservation. The reports are on the Chief Cliff district and adjacent areas by Johns and McClernan (1969), on soil sampling results in the Chief Cliff district and adjacent areas by Johns, Lawson, and McClernan (1970), on geologic reconnaissance and soil-sample investigations of the Ravalli-Dixon-Perma-Camas Prairie area by Johns, McClernan, and Lawson (1971), a preliminary report of geochemical soil sampling, Perma sills and Revais dike by Johns (1975) and a determination of Ag, Cu, Ni, and Pb threshold in soil samples from the Perma sills by Pederson (1975).

GEOLOGIC SETTING

The Flathead Indian Reservation lies in the Rocky Mountain trench, which extends from the southern part of the reservation northwest into Canada. The trench is bounded on the east by the Mission Mountains and on the west by the Salish Mountains, thus encompassing all the Mission Valley (Figure 1). The western part of the reservation is part of an anticlinorium that parallels the trench.

The reservation is characterized by north- and northwesterly-trending folds, abundant northwesterly and northeasterly trending normal faults, some easterly trending strike-slip faults, and some northwesterly and northerly trending thrust faults. Only some of these structures can be shown at the scale of Figure 4. The normal faults form a complex pattern of horst and grabens. The largest fault zone (called simply "the Mission fault") is along the base of the west side of the Mission Range; it has a total displacement of about 10,000 feet. Although some of the faults may be Late Precambrian in age, the faults forming the basins and ranges are Paleocene to early Eocene in age (55-65 million years ago), and some of them have had small recurrent movement into recent time. The loci of many historic and present-day earthquakes are along the Mission fault, although the most active fault in the past few years is the easterly-trending fault near the northern boundary of the reservation.

Bedrock exposed in the area are Precambrian and Tertiary in age (Figure 4). The oldest Precambrian rocks are in the western part of the area whereas the youngest are in the southeastern part. The Tertiary rocks, mostly volcanic in origin, are in the northwestern part of the area, in the vicinity of Niarada (Figure 4). The age of the volcanic activity is mid-Tertiary (unpublished K-Ar data, J. D. Obradovich). The largest area of volcanic rock is present north of the reservation and it surrounds one or more intrusive masses at and near the Flathead mine in the Hog Heaven district, about 8 miles north of Niarada. The volcanic rocks are described by Johns (1970, p. 58-61). The Hog Heaven district contains silver-lead replacement deposits associated with latite and andesite (Shenon and Taylor, 1936). A small exposure of a similar intrusive is on the ridge north of Camas.

Other intrusive rocks, in the form of sills and dike-like bodies, are common in the southwestern part of the reservation (Figure 4, Table 1). In places, such as at the Green Mountain mine, they are cut by a mineralized shear zone (Trauerman and Reyner, 1950; Crowley, 1963).

The valleys are filled by Tertiary sedimentary rocks (Late Eocene and Oligocene, 40 to 26 million years ago), and Quaternary glacial, lake, and stream deposits (Table 1). Tertiary sedimentary rocks are mostly in the deeper part of the basins, although some are exposed southwest of Niarada, and in places along the Flathead River (Soward, 1965). The glacial till and lake deposits in the area have been studied by Pardee (1910), Noble (1952), and Alden (1953). Gravity data indicate that the combined thickness of valley fill sediments are as much as 4,000 feet along the east side of Flathead Lake Basin, about 3,000 feet in the Polson and Irving Flats Basin, and about 800 feet in the central part of the Little Bitterroot Valley (La Point, 1973).

TABLE 1

Rock Units Exposed on the Flathead Indian Reservation

Quaternary System.

Holocene Series.

Alluvium.--Gravel, sand, and silt; unconsolidated. Particularly abundant along Flathead and Jocko Rivers. Deposits range in thickness from 1 to 50 feet.

Pleistocene Series.

Lake beds.--Largely silt, some clay and sand. Extensive deposits along wide valleys of Flathead and Little Bitterroot Rivers. Deposits range in thickness from 1 to more than 300 feet.

Glacial and glaciofluvial deposits.--Gravel, sand, silt, and clay; generally unconsolidated. Fills all major valleys; thickness not known in Mission Valley where depth to bedrock is about 4,000 feet. Deposits range in thickness from 1 to 2,000(?) feet.

Tertiary System.

Oligocene Series.

Volcanic and related rocks.--Latite and minor basalt flows, ash fall tuff, latite porphyry. Exposed only in northwestern part of reservation. Unit ranges in thickness from 1 to more than 300 feet.

Older valley fill.--Mostly consolidated conglomerate, breccia, and pebbly sand where exposed; gritty clay, siltstone, and sandstone reported in drill holes. Very limited exposures along Flathead and Little Bitterroot drainages; presumably fills the deeper parts of those old valleys. Fill ranges in thickness from 1 to 3,000(?) feet.

Precambrian System.

Mafic sills.--Quartz diorite to gabbro; larger sills may have granodiorite top. Most abundant in Prichard Formation in southwestern part of reservation. Sills range in thickness from 10 to 600 feet (each).

McNamara Formation.--Red and green argillite and siltite; parts contain green chert layers and chips. Exposed only in southeastern part of reservation. Formation ranges in thickness from 3,400 to 4,000 feet.

Bonner Quartzite.--Pink to maroon feldspathic crossbedded quartzite. Exposed only in southeastern part of reservation. Formation is 1,000 feet thick.

Mount Shields Formation.--Lower part is interbedded maroon and minor green argillite, siltite, and quartzite; middle part is mostly maroon planar--bedded feldspathic quartzite that has local carbonate streaks; upper part is largely maroon argillite and siltite but with a green bed zone near top. Exposed only in southeastern part of reservation. Formation is 6,000 feet thick.

Shepard Formation.--Dominantly dark and light green dolomitic argillite; limestone lenses and pods common; scattered red argillite beds. Commonly has a zone of stromatolites and oolites near base. Common in the eastern part of the reservation. Formation ranges in thickness from 1,000 to 2,600 feet.

Snowslip Formation.--Interlayered and interbedded red and green argillite and siltite; some maroon quartzite. Commonly has chlorite on bedding surfaces. Exposed in southeastern part of reservation. Copper sulfides in some green beds. Formation ranges in thickness from 3,000 to 3,800 feet.

Helena-Wallace Formations.--Gray to black silty limestone and dolomite, green dolomitic siltite with many horizontal and vertical limestone pods and vertical calcite ribbons; black or black and gray laminated argillite; green argillitic siltite and silty argillite. Slump structures and stromatolites common. Exposed in eastern half of reservation. In that area carbonate-rich rocks (Helena Formation) are abundant in the east and clastic rocks (Wallace Formation) more abundant in the west; formations interfinger. Unit ranges in thickness from 9,500 to 10,000 feet.

Empire Formation.--Dark green-light green laminated dolomitic argillite and siltite. Limestone layers and pods common. Exposed in eastern half of reservation. Lower two-thirds may contain copper sulfides, particularly near base. Formation ranges in thickness from 1,000 to 1,600 feet.

Spokane Formation.--Maroon to purplish-gray argillite or laminated argillite and siltite interlayered with green laminated argillite and siltite. Scattered thin white quartzite lenses. A zone of purplish-gray coarse siltite layers near middle. Exposed in much of the reservation. Copper sulfides in some green beds, particularly near the middle siltite zone. Formation ranges in thickness from 3,400 to 3,600 feet.

St. Regis Formation.--Upper 900 feet mostly purple argillite; lower 2,200 feet mostly purplish-gray siltite with interlayered quartzite and argillite. Some interlayered green argillite and siltite in both units. Interfingers with the Spokane Formation. Exposed in south-central part of Reservation. Copper sulfides in some green beds. Formation is 3,100 feet thick.

Revett Formation.--Dominantly purplish-gray, blocky, cross- bedded coarse siltite and very fine-grained quartzite; interlayered with purple or green argillite or laminated argillite and siltite. Exposed in much of the reservation. Formation ranges in thickness from 800 to 1,800 feet.

Burke Formation.--Purple, gray, and green interbedded argillite and siltite; tiny euhedral magnetite crystals common. Exposed in much of the reservation. Copper sulfides in some green beds. Formation ranges in thickness from 4,000 to 7,500 feet.

Prichard Formation.--Upper 4,000 feet black and gray laminated argillite, commonly pyrrhotitic; lower part contains, in addition, gray-green micaceous quartzite, green argillite and siltite, and some white quartzite. Mafic sills common, particularly in lower part. Underlies most of the southwestern part of reservation. Unit is 20,000+ feet thick.

GEOPHYSICAL SURVEYS

General

Aeromagnetic, ground magnetic, gravity, and telluric resistivity current surveys have been conducted in and near the Flathead Indian Reservation. The aeromagnetic and gravity coverage in the reservation are shown on Figure 5 and Figure 6. Ground magnetic, gravity, and telluric resistivity studies were conducted at Camas Hot Springs (Hawe, 1975) and are not discussed in detail in this report. Detailed gravity studies were conducted by LaPoint (1973) in the southern part of the reservation.

Aeromagnetic Survey Data

The total intensity aeromagnetic data shown on Figure 5 are from parts of three surveys. The survey in the northeast was flown by the U.S. Geological Survey across the Mission Range (Kleinkopf and Mudge, 1972). The flight line spacing was about 1 mile, orientation was east-west, and the elevation was constant at 9,000 feet above sea level. The survey to the west was flown by Lockwood, Kessler, and Bartlett, under contract to the U.S. Geological Survey. Flights were along east-west lines about 1 mile apart and at a barometric elevation of 7,000 feet. The aeromagnetic data in the south were obtained from the University of Montana (Douglas, 1971). Traverses were flown north-south, about 1 mile apart, and at a barometric elevation of 7,500 feet.

The most intense magnetic anomalies in or near the reservation are related to igneous intrusions and sedimentary rocks that contain relatively high percentages of magnetite. To the west and northwest most magnetic features associated with exposed intrusives are circular positive anomalies of 200-400 gammas in amplitude (Kleinkopf, Harrison, and Zartman, 1972). The magnetic data also indicate the subsurface extent of exposed intrusives and locations of concealed intrusives.

Positive anomalies, possibly reflecting buried intrusives, are along the western and southern boundaries of the reservation (Figure 5). Positive nosing of magnetic contours are present in the northwestern corner of the reservation, east of Lonepine, and at Camas; they also may reflect buried intrusives.

The igneous sills in southwestern part of the reservation (Figure 4) are not reflected by the magnetic data, whereas the igneous sill across the southern boundary between Edith and Charity Peaks is reflected by a northwest trending elongate magnetic anomaly.

Sedimentary positive anomalies, especially over the rocks of the Ravalli Group, were noted west of the reservation (Kleinkopf, Harrison, and Zartman, 1972). These anomalies typically are 50-100 gammas in amplitude and are elongated along structural trends where outcrops of the Ravalli Group are topographically high. The positive elongate anomaly west of Camas may be reflecting topographically high outcropping magnetite-bearing rocks of the Ravalli Group. As noted by Kleinkopf, Harrison, and Zartman (1972): "It is not always possible to distinguish 'sedimentary' anomalies from anomalies caused by igneous rocks. Some of the positive magnetic anomalies over sedimentary Burke terrane may indeed be caused by concealed igneous intrusives." The Burke Formation (part of Ravalli Group) crops out in the area west of Camas.

Bouguer Gravity Survey Data

The Bouguer gravity data are shown in Figure 6. The control consists of 665 gravity stations collected by various workers engaged in geologic structural studies and water resource investigations (Kleinkopf and others, 1975; LaPoint, 1973; and Boetcher and McMurtrey, in preparation). The surveys were tied to the international gravity base at the Kalispell, Montana, airport (Woollard and Rose, 1963).

The gravity data on Figure 6 show both positive and negative anomalies. The positive anomalies are mainly the nosing of contours in the western and southern part of the reservation. They reflect the exposed sedimentary rocks in those areas. Gravity data are too sparse in these areas to aid in evaluating the positive magnetic anomalies. The negative anomalies are mostly in the valleys and reflect the thick valley fill as shown in the cross sections on Figure 7 by LaPoint (1973).

MINERAL RESOURCES

General

Mineral resources of the Flathead Indian Reservation include gold, silver, copper, lead, platinum, palladium, building and ornamental stone, clay, and sand and gravel. The energy resources may include geothermal areas and an unknown uranium potential.

Metallic Mineral Resources

General

Metallic minerals in and near the reservation include gold, silver, copper, lead, platinum, and palladium. No uranium minerals have been reported from the area.

Mineral district data indicate possible zoning of metallic resources on the reservation (Figure 8). The Nine Mile District is primarily gold. To the north the Revais Creek District is mainly copper-gold-silver, whereas further north in the Camas Prairie District and west in the Plains District the main metallic resources are silver and lead. Resources in Hog Heaven District are also silver and lead. Additional regional data are necessary to determine the significance, if any, of the zoning.

The isotopes of lead in veins in the Seepay and Hog Heaven District are Mesozoic-Cenozoic in age, whereas lead in Kennedy Creek area, south of the reservation, is Precambrian (Kleinkopf, Harrison, and Zartman, 1972). The importance of the age is stated by Sahinen, Erdmann, Weissenborn and Weis (1968): "The metalliferous ore deposits of the State--and especially those of gold, silver, copper, lead, zinc, and tungsten--in most cases are closely associated with igneous intrusive rocks of intermediate to acidic composition, particularly those that were intruded in Late Mesozoic to Early Tertiary time."

Copper

Vein Deposits

Within the reservation, copper minerals occur in veins and in some Precambrian sedimentary rocks. The reported occurrences are shown on Figure 8.

Copper-bearing veins are in the Revais Creek, Seepay, Camas Prairie and Chief Cliff mining districts (Figure 8). The prospects in these areas are discussed by Crowley (1963), Johns and McClernan (1969), Johns, Lawson, and McClernan (1970), Johns, McClernan, and Lawson (1971), and Johns (1975). Other copper-bearing veins are common in the Nine Mile District south of the reservation (Sahinen, 1957). Commonly the copper minerals occur as widely disseminated sulfides in quartz veins. Some analytical data indicate as much as 16 percent copper over 4.5 feet width, but more commonly the veins contain less than 2 percent copper. Copper also occurs in a clay zone adjacent to a mafic dike in the Revais Creek district.

Stratabound Copper Deposits

Copper occurrences in Precambrian sedimentary rocks in the reservation are shown on Figure 8. The copper is in green strata, which is a common mode of occurrence in Precambrian rocks in northwestern Montana (Harrison, 1972). The green strata, with shows of copper, are in the Revett, Burke, Spokane, Empire, and Helena Formations; the most common occurrences are in the Burke and Empire Formations. The Burke is exposed locally in the central and western parts of the reservation;

the Empire is exposed locally in the eastern part. The Empire is composed entirely of green argillite and siltite, whereas the Burke is purple, gray, and green interbedded argillite and siltite (Table 1).

The copper minerals are disseminated in small pods and thin lentils, and include malachite, chalcopyrite, chalcocite-digenite, or bornite. Analyses of the samples shown on Figure 8 range from 50 to 7,000 ppm in copper, but none of the zones of anomalous amounts of copper appear to constitute a potential copper deposit. However, a zone near the base of the Empire Formation just north of the reservation does contain a potential copper deposit, so the limited sampling of that zone on the reservation may not be an adequate representation of its potential for copper ore. In the Mission Range, Harrison, Reynolds, Kleinkopf, and Pattee (1969, p. D17-Dl9) found that copper minerals are present in many places in Belt rocks, but not in sufficient abundance to form large low-grade ore deposits.

Favorable rock types are on the reservations and the possibility of finding extensive low-grade copper deposits is ample reason for a comprehensive sampling program.

Gold

Gold is present in minor amounts in the mineralized veins in the Revais Creek and Camas Prairie District (Crowley, 1963). A gold placer claim is recorded in the Elmo area by Gilbert (1935, p. 35), but no other data concerning the property are available. Gold also occurs in veins and placers in the Nine Mile Creek District south of the reservation (Sahinen, 1957).

Geologic data indicate that any older Quaternary gravel remaining in Revais Creek, adjacent to and downstream from the Drake (Green Mountain) group of mines, should contain placer deposits of gold. The mines upstream produced considerable gold from exposed veins. Also, south of the area, placer mining was conducted along Nine Mile Creek and its southerly flowing tributaries which intersect similar gold-bearing veins.

Silver

Silver is a common constituent in all veins in the districts in the southern part of the reservation and in copper-bearing sedimentary rocks. It is a major constituent in the silver-lead deposits in the Hog Heaven District north of the reservation (Shenon and Taylor, 1936).

Lead and Zinc

Small amounts of lead have been produced from deposits in the reservation. Lead is a common commodity in the Hog Heaven District to the north and in the Plains District to the southwest. No zinc has been produced on the reservation, but it occurs near the reservation.

Platinum and Palladium

Platinum and palladium are reported in the Revais Creek District by Crowley (1963, p. 36) who quotes an unpublished report by Sahinen (1936). The gabbro in the mines contains as much as 0.10 ounces of platinum group metals per ton; the average of 30 analyses was about 0.03 ounce per ton. The material reported as platinum group metals is usually two-thirds palladium and only one-third platinum. Incomplete smelter returns on the Green Mountain mine ore suggested it contained 0.08 ounce of platinum per ton (U.S. Geological Survey, unpublished data, 1955).

History and Production

General

More than 10,000 tons of copper ore have been mined within the reservation. Most of the ore shipped from 1910 through 1949 has come from deposits on tribal land.

A 1974 decision by the Montana State Office of the Bureau of Land Management (BLM) declared a dozen unpatented mining claims null and void ab initio; that is, the initial date of location was prior to the allowed date of entry, or the claim was located on land specifically classified as "timber," and not open to mineral entry (BLM decision 943.8:m 28355, 1974). The decision was appealed in 1975 and was upheld by the Department of the Interior Board of Land Appeals (IBLA 74-308, 1975). The decision returns these claims to the jurisdiction of the Confederated Salish and Kootenai Tribes. Legal principles in this validation case might apply to other unpatented claims on the reservation.

Mining Districts

Definitions.--The boundaries of the five mining districts in the Flathead Indian Reservation are loosely defined (Figure 9).

The Seepay Creek and the Revais Creek districts are defined by drainage patterns. Rock type seems to be the major factor defining the Hog Heaven district where the rich silver deposits of the district occur in Cenozoic volcanic flows and intrusions. The Hog Heaven deposits are mined a few miles north of the reservation; however, the host rocks are known to extend into the reservation.

The relatively indefinite boundaries of the Camas Prairie and Elmo districts enclose scattered mines and prospects along the western and northern edges of the reservation.

Revais Creek.--The Revais Creek mining district, also called the Dixon district, encompasses an area of approximately 32 square miles, and is centered about 5 miles southwest of the town of Dixon. Eighty-five percent of metallic mineral production from the reservation has come from this district. More than 9,000 tons of copper ore and concentrates were shipped from the district between 1910 and 1949 (Table 2). Most of the production came from the Green Mountain (or Drake) group of claims located in sec. 4, T. 17 N., R. 23 W., and sec. 33, T. 18 N., R. 23 W. This group consists of the Dixon, Eagle, Lucky Strike, Trade Dollar, and May Flower claims. A number of other claims were staked but proved nonproductive and were abandoned (Figure 10).

The BLM validation case of 1974 (BLM decision 943.8:m 28355) affected seven claims in the Revais Creek district: the entire Green Mountain group, the Blue Ox, and Slow Poke claims. A mineral survey was performed on the Blue Ox, Slow Poke, and May Flower claims in 1962 as required for patent application. However, no patents were issued.

TABLE 2
Gold, Silver, and Copper Production, Revais Greek (Dixon) District

Year	Ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)
1910	28	11	42	6,096
1911	24	9	32	5,593
1912	26	12	32	5,149
1913	38	41	64	9,987
1915	58	8	93	15,056
1916	15	--*	24	6,299
1917	19	--	48	8,278
1918	54	--	9	4,857
1919	28	6	22	5,597
1920	22	l	22	4,585
1922	22	3	26	4,511
1925	25	11	37	5,905
1931	88	39	67	12,534
1932	618	98	546	106,254
1933	50	6	43	9,859
1935	76	11	103	14,265
1936	134	15	71	26,837
1937	698	79	733	96,380
1938	62	7	48	4,694
1939	287	46	389	153,336
1940	592	150	682	225,319
1941	2,458	66	367	92,000
1942	800	12	83	4,300
1944	25	7	45	17,400
1945	412	74	225	74,600
1946	723	259	542	138,000
1947	908	192	715	183,300
1948	694	105	526	132,800
1949	115	9	116	19,000
TOTAL	9,099	1,277	5,752	1,392,791
Av. Grade		0.14 ounce per ton	0.63 ounce per ton	7.65%

*None reported.

From Montana Bureau of Mines and Geology Bull. 34.

The veins in the Revais Creek District contain copper, gold, silver and lead; 1,392,791 pounds of copper was produced between 1910 and 1949 (Crowley, 1963, p. 36). The shipped ore contained about 153 pounds of copper per ton.

The area contains gabbroic sills and dikes that intrude the Prichard and Burke Formations. Numerous faults and some folds are in the area. Most known mineralized veins in the area cross-cut the basic intrusive rocks and are along faults or sheared zones.

The Drake (Green Mountain) mine in Revais Creek produced most of the ore in the District, -- (Trade Dollar, Dixon, and Eagle claims.) The main ore body is localized in a fault zone along the contact between a gabbro dike and Ravalli Quartzite (Johns, McClernan, and Lawson, 1971, p. 107). Crowley (1963, p. 38), citing an unpublished report by E. F. Elstone (1955), describes the ore as being in a crushed and altered zone that is highly variable in thickness, in places in quartz veins 1 to 5 feet thick, and elsewhere in clay seams. The clay is rich in copper. The zone strikes due north and dips from 60º to 90º E at the north end, and from 45º to 90º W at the south end. The highest grade ore in the mine contained 11.88% copper, but the copper content is highly variable because much of it has been leached (Johns, McClernan, and Lawson, 1971, p. 10; Crowley, 1963, p. 38). The important ore shoot rakes to the south (Figure 11).

The enriched zone is made up of both an oxide zone and a zone of secondary chalcocite. The oxide zone goes from the surface to a depth of about 80 feet and contains malachite, chrysocolla, cuprite, and tenorite. The oxide zone is underlain by the secondary chalcocite zone which is about 30 feet thick. The enriched zone grades into a zone of primary mineralization containing chalcopyrite, chalcocite, and bornite. An appreciable amount of silver, gold, and platinum-palladium was recovered from both oxide and sulfide ores. The mode of occurrence of the precious metals is not known.

Other workings on the group on or adjacent to the Revais Dike include three adits and several open cuts on the Lucky Strike claims; an adit on the Mayflower, plus an adit and several short drifts on the Blue Ox and an adit on the Slow Poke.

Exploratory work in another major dike (striking northwest) includes shafts, adits, trenches, and pits on the Bay Horse, Blue Bell, Pine Cone, and White Cloud claims (Figure 10). There is no record of production from the latter claims. Workings on the Bay Horse (also called Coyote) have been mapped and sampled (Pattee, 1958). A grab sample taken from a shaft located within a mineralized zone in the intrusive diorite assayed 1.71 percent copper, and a grab sample from a stockpile contained 2.79 percent copper.

Recent exploration in the Revais Creek district was completed by geologists from the Montana Bureau of Mines and Geology as part of a geochemical prospecting program that covered most of the mining districts in the reservation (Figure 12). Known high-grade mineral deposits apparently are restricted to the contact zone between mafic intrusives and the Ravalli quartzite. Disseminated copper minerals occur in the intrusive rock. For these reasons, sample traverses were located to test contact zones and dike widths. Sampling results indicate three areas with anomalous copper values (Johns, 1975).

Other exploratory work in the Revais Creek mining district includes several holes drilled in the vicinity of the Green Mountain mine to test the contact zone. Diamond drill hole No. 1, shown on the longitudinal section of the Green Mountain mine (Figure 11), was designed to cut the ore shoot below the underground workings. Combined core and sludge assays from the 6-foot-wide vein intersection contained 7.32 percent copper, 0.83 ounce silver per ton, and trace gold (Green Mountain project No. 1454, 1943).

A second hole was drilled from a site located approximately 1,400 feet north of the Green Mountain shaft (Revais Creek, 1952). Because of poor core recovery, only a sludge sample from an 8-foot-long intersection of the gabbro-quartzite contact zone was assayed. This sludge assayed

0.45 percent copper, 4.6 ounces of silver per ton, 40.64 ounces of gold per ton, and 0.085 ounce platinum per ton. No further work was done to substantiate the high gold assay.

Because specific vein widths and grades are not available, an estimate of resources has not been made for the Revais Creek mining district. Projections based on the Green Mountain mine longitudinal section (Figure 11) indicate that the mineralized zone continues beneath the mine workings, and diamond drill hole No. 1 further confirms the downward continuation of the copper zone.

<u>Camas Prairie</u>.--Camas Prairie mining district, also called the Perma district, is the second-most productive district having produced 1,506 tons of copper ore. It contains the only patented mining claims on the reservation (Figure 13). The Glaucus group of claims (Glaucus, Cardiff, Cardiff No. 1, and Cardiff No. 2) were patented from 1912 to 1916. The group is in secs. 19 and 20, T. 19 N., R. 22 W., about 7 ½ miles northeast of Perma.

More than 90 percent of copper ore shipped from the Camas Prairie district was mined in the 1940's. Most of it came from workings on the Glaucus claim (Table 3). The first few tons shipped in 1912, 1917, and 1926, contained appreciable amounts of lead. The mineralogy of this ore is unknown.

More than 900 feet of crosscuts and drifts have been driven on a fissure vein which strikes east-west on the Glaucus claim. Near-surface ore was developed by workings driven from a 40-foot-deep shaft. Ore was also mined from deeper drifts, several small stopes, and a winze. All production was from the upper, oxidized portion of the vein. The identified copper oxides are malachite and tenorite. Chalcopyrite, a copper sulfide, is reported at the bottom of the winze approximately 90 feet below the surface. This may mark the oxide-sulfide interface and copper sulfides may predominate below this level. In addition to the workings on the Glaucus claim, there are surface cuts and adits on other claims in the Glaucus group.

The Exchange and the June Bug mines, both in the district, have recorded production (Table 3). Their locations are not known. Additional prospects include the Dustan and Protection claims in sec. 29, T. 20 N., R. 24 W. (Figure 14), the Camas Copper Mining and Milling Co. claims near the Dustan property (Crowley, 1963), the Palin (Gilbert, 1935), and the Lucky Lead (Stout, 1954). The Dustan and Protection claims have been surveyed. The vein on the Dustan claim is reported to be 4.5 feet wide and to contain 16 percent copper and 2 ounces of silver per ton. The vein on the Camas Copper claim is said to be 3 to 4 feet wide and to contain 18.1 percent copper and 1 ounce silver per ton (Crowley, 1963). In spite of these high values there has been no reported production.

TABLE 3

Gold, Silver, Copper, and Lead Production, Camas Prairie District

Year	Ore (tons)	Gold (ounce)	Silver (ounce)	Copper (pound)	Lead (pound)
			Glaucus mine		
1912	3	-*	88	162	2,532
1917	3	-	71	204	1,159
1926	1	-	34	22	941
1942	10	-	14	1,700	-
1943	77	1	135	5,300	-
1944	233	4	405	19,400	-
1945	345	5	585	25,800	-
1946	430	8	578	31,200	-
1947	302	3	379	21,500	-
Sub-total	1,404	21	2,289	105,288	4,632
			Exchange mine		
1915	13	-	14	1,931	-
1916	32	1	48	8,024	-
1917	33	1	40	7,174	-
Subtotal	78	2	102	17,129	-
			June Bug mine		
1916	24	-	10	1,463	-
District Grand Total	1,506	23	2,401	123,880	4,632
District Average grade		0.016 (oz/ton)**	1.59 (oz/ton)	4.11%	

*None reported.

**Calculated for seven years of gold recovery and three years of lead recovery.

From Montana Bureau of Mines and Geology Bull. 34.

A number of other prospects are in the district. A 7-foot-wide quartz vein containing 0.75 percent copper is exposed in a 50-foot-deep shaft on the Day, Cramer, Chapman property, located approximately 2 ½ miles northeast of Camas Prairie. Forty-eight tons of copper-bearing material is reported to have been shipped from the shaft. On the Dr. Brown property, located approximately 2 ½ miles south of Hot Springs, a 19-foot-deep shaft was sunk on two barren quartz veins. In sec. 18, T. 20 N., R. 25 W., several cuts expose a quartz vein 5 feet wide which assayed 0.3 percent lead and 0.83 ounce silver per ton. In sec. 31 of the same township, a 40-foot-deep shaft was sunk on a 3-foot-wide vertical quartz vein. Samples from the shaft dump average 0.2 percent copper and 0.9

ounce silver per ton (Anaconda Co., written commun., 1976).

Seepay Creek.--Mines and prospects in the Seepay Creek district are in a 20-square-mile area centered approximately 5 miles south of Perma. The Blue Eyed Nellie, Lucky Mart, Lucky Joe, New Deal, and Isabel claims, which make up the New Deal-group (Figure 15), are among those returned to the Confederated Tribes' jurisdiction by the U.S. Bureau of Land Management validity decision in 1974 (BLM, 1974). During the on-site investigation by BLM geologists in 1973 and the hearings in 1974 and 1975, these claims were referred to as the Vandenburg Lookout group.

Underground development began on the New Deal group in 1934. The only recorded production for the district, 18 tons of ore averaging 5.01 percent copper and 1.0 ounce silver per ton, was shipped in 1938 (U.S. Bureau of Mines, unpublished data). Workings on the New Deal claim consist of a discovery cut and a number of trenches and pits, none of which completely penetrate the overburden. No discovery work was found on the Lucky Joe and Isabel claims (Newman, 1973, p. 13-16). Mine workings on the Blue Eyed Nellie and Lucky Mart claims include an inclined shaft, now caved, and an adit, both located in a gabbro sill which strikes approximately N. 35º W.

A 30-inch-wide quartz vein exposed in the shaft strikes about N. 45º W. and dips about 47º NE. The hanging wall of the vein contains malachite, chrysocolla, and chalcopyrite. A sample of the 10-inch-wide highly mineralized portion of the vein, assayed 5.7 percent copper and 1.0 ounce silver per ton. A 20-inch-wide sample, from a more barren portion of the vein, contained 0.2 percent copper and 0.2 ounce silver per ton (Newman, 1973).

The adit was mapped in 1963 but is now inaccessible (Figure 16). No copper minerals were seen during the mapping (Crowley, 1963, pl. 5).

The Lucky Lode prospect (Figure 15) is near the headwaters of Seepay Creek in sec. 6, T. 17 N., R. 23 W. The workings on this unpatented claim include two adits and a number of prospect pits which explore a vein of massive quartz that is as much as 6 feet wide (Figure 17). The vein contains scattered pyrrhotite, pentlandite, chalcopyrite, and galena. The only sample with a high metal content, 9.3 percent lead, 4.2 ounces of silver per ton, and 0.04 ounce gold per ton, came from a pit exposing a 1.4-foot-wide portion of this vein. Samples from a second quartz vein contain trace amounts of gold and silver.

Other prospects within the Seepay Creek mining district are indicated on the topographic map of the Perma quadrangle. Included are adits in secs. 26 and 36, T. 18 N., R. 24 W.

A recent program of reconnaissance mapping and geochemical prospecting by the Montana Bureau of Mines and Geology has outlined numerous targets, all centered around the Perma sills, that warrant further investigation (Johns, 1975; Johns and others, 1971). Over 14,000 soil and rock samples were collected during 1973 and 1974 (Figure 12). Most were from the Seepay Creek district, primarily from traverses across the Perma Sills. High silver values were found in several samples taken along a 500-foot traverse near New Deal workings (Johns, 1975, pl. 3). Elsewhere in the district, high nickel values were found in samples taken across an 80-foot-wide zone within a sill (Johns, 1975, pl. 5). In another area, a copper anomaly approximately 1,000 feet long and 600 feet wide warrants investigation (Johns, 1975, p]. 2).

These three targets, together with others which may be found through a re-evaluation of sample analyses, deserve closer scrutiny. Geologic mapping, additional sampling on a tighter grid, followed by trenching to expose mineralized zones would be the most practical and economical way to explore the targets. As platinum and palladium often occur in nickel-rich environments, their presence should be tested.

Elmo (Chief Cliff).--The Elmo mining district, also called Chief Cliff district (Figure 9), covers approximately 1 ½ townships of reservation land in Lake County near the west edge of Flathead Lake. The district also includes a few mineral occurrences that are north of the reservation boundary (Figure 8). This weakly mineralized area contains only scattered exploratory workings. Reports of small ore shipments have not been substantiated by smelter records.

In the 1930's, lode claims were located on quartz veins. Most of these locations are not identified on topographic maps nor are ownerships ascertained. The only claim names known in the district are the Chief Cliff and the Silverstone. Their locations are not known. Three other prospects are known in sec. 10, T. 23 N., R. 22 W. (Figure 18). The main working on these claims includes a 60-foot-long trench, 10 feet deep, which explored a vertical 2-foot-wide quartz vein. Samples of the vein contained 0.2 percent copper, 1.0 ounce silver per ton, and approximately 0.07 ounce gold per ton.

In 1969, the Planning and Development Center at Montana State University, acting for the Indians, requested that the Montana Bureau of Mines and Geology make a geologic study of the Elmo mining district. Johns and McClernan mapped workings and outcrops, and sampled a one ton stockpile in sec. 11, T. 24 N., R. 22 W. The samples contained abundant material which assayed 23.9 percent lead and 22.75 ounces of silver per ton. A 12-inch quartz vein containing chalcopyrite assayed 1.2 percent copper and 0.40 ounce silver per ton. Samples containing malachite, azurite, and chalcopyrite, from a dump in sec. 35, T. 24 N., R. 22 W., averaged 1.97 percent copper and 0.35 ounce silver per ton. Geochemical exploration (soil-sampling) was conducted over the more favorable mineralized zones (Figure 19). Results of this work indicate extensions of known veins and additional undeveloped structures (Johns and others, 1970). Additional exploratory work including geologic mapping, sampling, trenching, and drilling has been proposed by the Montana Bureau of Mines and Geology (Johns and others, 1970, p. 11-13).

Hog Heaven.--Rich silver ores have been shipped from the Flathead and West Flathead mines in the Hog Heaven mining district about 3 miles north of the reservation (Figure 9). Between 1928 and 1930, 1.5 million ounces of silver were produced (Shenon and Taylor, 1936, p. 14); the ore averaged about 75 ounces per ton. According to Johns (1970, p. 74) the total production in the district amounted to $6 million or more. The silver deposits, which also contain commercial amounts of lead and significant amounts of copper and zinc, are in a highly altered and silicified zone in a latite porphyry intrusive of Tertiary age.

The host rocks of the district extend southward into the reservation, but no claims have been located on the reservation. A geochemical stream--sediment sampling program conducted by the Montana Bureau of Mines and Geology (Sahinen and others, 1965) clearly defined the mineralized zone north of the reservation, but did not show it extending onto Indian land.

Although the stream-sediment sampling was not encouraging, two copper anomalies deserve further investigation. One is along the northern edge of T. 24 N., R. 24 W., and the other is at the mutual border of T. 23 N. and T. 24 N., R. 25 W. (Sahinen and others , 1965 , pl. 3). The reservation's Tertiary-age igneous rocks should be mapped and all altered or silicified zones sampled.

Miscellaneous Mineral Prospects and Occurrences.--The Big Chief group of claims in sec. 25, T. 17 N., R. 21 W. is approximately 7 miles from the Revais Creek mining district. The unpatented Big Chief claim (Figure 20) was surveyed, and it is the only one of three claims in the group on which exploratory work has been done.

Bennett (1942) mapped and sampled two veins exposed in a shallow trench on the Big Chief claim. A 1 foot wide vein assayed 0.9 percent copper and 0.3 ounce silver per ton, and a second vein, 1.5 feet wide, contained 1.7 percent copper and 0.2 ounce silver per ton. A crosscut adit was started toward the veins, but had not reached them at the time of the examination. Because of the low-grade and narrow width of the veins, and the absence of other claims or mineralized exposures in the area, additional field work is not warranted.

Isolated copper and lead anomalies, indicated by stream-sediment samples, occur along the eastern border of the reservation in the Mission Range (Sahinen and others, 1965). One anomalous area is attributed to a Tertiary quartz diorite dike with a copper content much higher than the surrounding rocks of the Belt Super Group. Other anomalous areas are believed to be derived from beds or members of the Belt formations that contain an above-average copper content (Harrison and others, 1969). Geochemical sampling indicates rocks on the crest of the Mission Range have little economic mineral potential.

At various times, tribal members have recovered small quantities of gold from placers along the southern edge of the reservation (personal commun. with tribal members, 1976).

Nonmetallic Mineral Resources

General

Nonmetallic mineral resources within reservation boundaries include barite, dimension (building) stone, other stone, clays, and sand and gravel. Past production from deposits on the reservation has been limited to sand and gravel and stone.

Barite

Two occurrences of barite have been reported on the reservation, One apparently occurs in the hills south of Round Butte (Weis, 1968, Figure 13); no other information on this occurrence is available. The other is a barite vein exposed on the ridge southeast of the Drake (Green Mountain) mine in Revais Creek (W. Johns, oral commun., 1975).

Clay

Commercial quality clay occurs on the reservation. The Montana Bureau of Mines and Geology completed a long-term investigation of clay and shale deposits in Montana; 47 samples were taken from the Flathead Indian Reservation (Sahinen and others, 1958, 1960, 1962; Chelini and others, 1965, 1966). Each of these has been tested for use as a ceramic raw material or as a possible source of expanded shale for lightweight concrete aggregate, and analyzed as a possible source of alumina for the production of aluminum.

The testing procedures included X-ray diffraction analysis to determine the mineral composition, chemical analysis, ceramic tests to determine physical properties, and bloating tests to determine expendability for lightweight aggregate.

Of the 47 samples tested, 19 have no apparent commercial value. Twenty-eight have one or more properties making them acceptable for ceramic use. They represent material that can be used for making common brick, either directly or by blending with other clays. One sample displayed good plasticity and firing characteristics necessary for pottery clay. One sample with good bloating properties contained material suitable for lightweight concrete aggregate. The final pellet product is well glazed and has a fairly coarse but strong cell structure. None of the samples contained sufficient available alumina (+19 percent) to be considered as an ore of aluminum.

Figure 21 shows the location of all clay samples collected on the reservation. Those with commercial possibilities are listed in Table 4 and are numbered in Montana Bureau of Mines and Geology publications which also list the important chemical and physical properties of each sample including: water of plasticity, drying and firing shrinkage, firing temperature, fired color and hardness, expansion temperature range, mineral identification from X-ray analysis, and chemical analysis including available alumina.

Most of the clay samples were collected in Mission Valley which was formerly occupied by Glacial Lake Missoula. Clays derived from the erosion of Belt argillites, quartzites, and limestones were deposited in the lake. After it drained, the clays were eroded, reworked by streams, or were covered by glacial gravel and flood plain silt. Many samples are from clay-gravel mixtures or clay interbedded with silt. The sample location map (Figure 21) shows the erratic distribution of commercially acceptable clays. An extensive sampling program is needed to delineate the boundaries of deposits with commercial value.

Although all of the clay samples listed are within the reservation boundary, most were collected on land owned by non-Indians (compare Figure 2 and Figure 21). However, a number of the sample sites are near Indian-owned land, and the thickness and quality of these exposures should encourage the exploration for clay on tribal land.

Building Stone

Stone has been quarried in and near the reservation for dimension stone, rubble, or flagstone. Selected argillite members from the Prichard Formation and the Ravalli Group meet the criteria for flagstone; volcanic sandstone and indurated tuff are quarried for interior decoration; and rock from diorite sills and dikes may have potential for use as facing stone (Figure 22).

Large areas containing argillite of the Prichard Formation are present in the western part of the reservation (Figure 4). Rock suitable for building stone was noted by Johns and McClernan (1969) in the NE ¼ NW ¼ sec. 18, T. 24 N., R. 2 W., about 100 yards northeast of a shaft. The rock is argillite which is jointed in two directions so that blocks 6x18x30 inches can be obtained; it has a pleasing light brown color and is very hard and durable (Johns and McClernan, 1969, p. 17).

West of the reservation two quarries in argillite in the Prichard Formation have produced flagstone and rubble (Berg, 1974, p. 24). A quarry along the Clark Fork River, in the NE¼ sec. 14, T. 18 N., R. 26 W., produced thin slabs of flagging according to Berg (1974, p. 24). He believed the iron oxide coating produces a pleasing color, but would tend to run on exposed surfaces. Therefore, the stone should be more suitable for interior decoration. The other quarry is located in the SE¼ sec. 2, T. 19 N., R. 26 W., and according to Berg (1974, p. 24) some of the stone was marketed on the west coast as "Montana Slate."

A quarry (Flathead Sunset) produces rubble just north of the reservation in the NW¼ NE¼ sec. 34, T. 25 N., R. 24 W. Absorption tests by Berg (1974, p. 26) indicated that the stone should not be used where it may be subject to excessive moisture and repeated freezing and thawing.

Berg (1974, p. 16, 24) examined some road cut exposures of rock in the reservation for suitability of construction stone. Berg (1974, p. 16) examined a metagabbro sill in the NE¼ SW¼ sec. 31, T. 19 N., R. 23 W. and determined it unsuitable for dimension stone because of the abundant irregular fractures. Exposures of argillite in the Prichard Formation in road cuts in the N½ sec. 31, T. 21 N., R. 24 W. were found by Berg (1974, p. 24) to be too fractured for flagging or rubble and he doubted that adequate suitable rock could be quarried at depth. Large amounts of argillite in the Prichard Formation suitable for flagging was noted by Berg (1974, p. 24) in a road cut along Montana State Highway 282 at Markle Pass in the NW¼ sec. 25, T. 21 N., R. 24 W. found in the northwestern corner of the reservation. At the Flathead Sunset Quarry, on state land less than 1,000 feet north of the boundary line, an indurated tuff with a rough shape called "rubble" is being quarried. Rubble is stone which is roughly tabular with at least one fairly flat face. Five miles southeast of this quarry, volcanic sandstone has been quarried. Samples of both volcanic rock types have a high water absorption capacity, which dictates that the stone is suitable for interior decoration only.

From a highway roadcut south of Perma, a sample was collected from one of the many diorite intrusives in the area. This greenish black rock is dense, fine- to medium-grained, and uniformly textured. However, this particular specimen had too many fractures to be considered for building stone. Other dikes and sills may be sources of larger pieces of diorite that are free from close--spaced fractures and jointing.

Carbonate rock in the Helena Formation is locally exposed in the eastern part of the reservation. The formation contains even beds of limestone, dolomitic limestone, and dolomite with much shaly and siliceous impurities. Numerous analyses are recorded on samples from this formation in the Mission Mountains (Harrison and others, 1969, p. D30-D36). They (1969, p. D21) noted that a few layers approached cement rock in quality but most are too thin to be commercial. The thicker beds, where readily accessible in the reservation, may be suitable for building stone, crushed aggregate, or riprap.

In addition to the sampled localities, two other quarries, shown on the Polson topographic sheet, are several miles south of Polson. No description of them was found in the literature, but apparently they are in argillite or quartzite beds of the Ravalli Group. Also, argillite found near Elmo has desired building stone qualities of color, texture, and durability (Johns and McClernan, 1969, p. 17).

Sand and Gravel

Many sand and gravel deposits are found on the reservation (Figure 23). Topographic maps show 43 sand and gravel pits which supply, or have supplied dam and road builders, the railroad, and the building construction industry. In addition to the deposits already being mined, there are several dozen additional sources (Larrabee and Shride, 1946). These reservation resources range from unsorted glacial deposits to well sorted, clean outwash sands and gravels.

Some of the larger deposits have been mapped in the reservation by Alden (1953), and smaller stream deposits of nonglacial origin have been locally mapped by Soward (1965) and Wells (1974), and are recorded on unpublished maps by J. E, Harrison,

The larger deposits, as mapped by Alden (1953, pl. 1), are alluvial deposits along bottom lands and low terraces and may include outwash deposits of possibly latest Pleistocene age. They occur along Mission Creek, west of Elmo, along a northeastern tributary of Little Bitterroot River, in the upper reaches of Jocko River from south of Ravalli to the eastern border of the reservation, and east of the Flathead River northwest of Moiese. Alden (1953) also shows many remnants of the highest bench of stream terraces and alluvial fans along streams emitting from canyons on the west side of the Mission Range, northwest of Arlee and east of Evanro. These deposits are mostly coarse gravel derived from the mountain.

Five localities of bar and gulch fillings in glacial lake deposits were mapped in the reservation by Alden (1953, pl. 1). Two deposits are located about 4 and 5 miles north of Camas Prairie. One is just west of Perma and another about 4 miles further west. The last deposit is about 4 miles east of Ravalli. In the Camas Prairie area, Alden (1953, p. 96) describes the deposits, from exposures in gravel pits, to be partly stratified gravel and largely angular to subangular, partly sorted rock fragments. In road cuts, about 3 miles southwest of Polson, he (1953, p. 119) noted deposits of fine sand and interbedded gravel. Similar deposits are in pits a short distance west of the road cuts.

Potential deposits of sand and gravel along the Flathead River from the Moiese Valley southwest to the Clark River, are discussed by Soward (1965, p. 20-22). All deposits he examined appear to be deficient in medium and fine sand.

Energy Resources

General

Geothermal is the only known potential energy source in the reservation. The geologic setting is not favorable for oil and gas or coal, but tribal members have reported coal. Tertiary lake beds are present, but mostly buried by Pleistocene glacial till and glacial lake beds. The exposed Tertiary strata, reported by Soward (1965), are not the type that contains beds of coal or oil-bearing shale as found in some other Tertiary basins in northwestern Montana. The literature does not contain any record of uranium in the Tertiary volcanic rocks in the northwestern part of the reservation. Low grade uranium deposits are locally present in similar rocks elsewhere in western United States.

Geothermal

The curative and restorative power of the Camas hot springs has been utilized by a commercial enterprise on the reservation for over 60 years. Geothermal waters are found near the western edge of the reservation in T. 21 N., R. 24 W. (Figure 22). Although the Hot Springs resort depends on one spring with a flow of 24 gallons per minute at 120ºF, there are a half-dozen others which could augment this supply. They are along a 2-mile-long fault zone which strikes east-northeast. Five miles from the springs is an area containing 10 artesian wells with a maximum water temperature of 128ºF. One of these has been developed for hot mineral baths (Crosby and others, 1974, p. 1).

The type and location of the heat source for these waters has an important bearing on potential geothermal resources. Five geophysical surveys were carried out to better define the heat source. Gravity, magnetic, electromagnetic, seismographic, and telluric resistivity methods were used (Crosby and others, 1974). Results from the magnetic and telluric surveys suggest the presence of an intrusive body north of the town of Hot Springs topping out at a 600-foot depth. Although this intrusive could be correlated structurally with the Precambrian Perma sill, geophysical data indicate a separate intrusive body.

Another study involved drilling a hole close to the hot springs fault zone to a depth of 300 feet and measuring the water temperature. A normal increase in temperature with depth is about 1ºC per 100 feet. For the first 200 feet of the hole, the temperature increased by almost 6ºC per 100 feet, but below 200 feet it abruptly decreased to a normal gradient (Qamar, 1975, p. 4) indicating that the hole is not near a significant hot igneous body.

The present hot water sources can supply heat for hydroponics. This involves growing vegetables, fruits, grains, and flowers in a nutrition-rich water solution in a hothouse environment. The greatest expense is the heating required to maintain a minimum temperature for the root systems of the plants (Flynn, C. F., Hydro-Gro Co., Helena, MT, 1975, personal commun.). The use of geothermal well and spring water to furnish a cheap, constant supply of heat avoids the cost and supply vagaries of commercial power sources.

Hydroelectric Power

Kerr Dam, a source of hydroelectric power, is on the lower Flathead River, 4.5 miles southwest of Flathead Lake. The damsite is rented from the

Confederated Salish and Kootenai Tribes. Since 1938 when Kerr Dam went into operation, the Flathead River, which discharges from Flathead Lake and flows through reservation land for most of its 76-mile length, has been the subject of a series of dam and reservoir studies (Soward, 1965). Many of the potential sites are on Indian-owned land, and construction of new dams would mean additional rental fees for the Confederated Tribes.

The U.S. Geological Survey, Corps of Engineers, and Montana Power Co. have conducted exploratory mapping and drilling programs. The Montana Power Co. has an application pending before the Federal Power Commission for the construction of a dam downstream from Kerr Dam (Figure 22).

Coal

Two occurrences of coal on the reservation are reported by tribal members (Figure 22). One is in the southeastern corner in or near a swampy drainage called Liberty Meadows, probably in secs. 21, 22, 27, and 28 in T. 16 N., R. 17 W. The other location is less well-defined, being between Saddle Mountain and Valley Creek about 6 miles west of Arlee. These deposits may be peat or a low rank lignitic coal of minimal value as a fuel. Quality and reserves are not known. Peat is mined in the Swan Valley a few miles east of the reservation.

MINING AND MILLING

Known and potential mineral deposits on the Flathead Indian Reservation can be mined by a variety of methods. Surface excavation to quarry building stone, and to mine sand and gravel, has been used by the Indians and will be continued as the best method for mining these commodities. Clays can be mined by selective surface stripping involving the removal of shallow overburden, then mining the relatively thin beds of commercial clay.

Highly selective underground mining methods have been used since 1910 to mine the narrow, high-grade metal vein deposits. If the rock surrounding the vein should contain profitable metal values, then a large-tonnage, less selective method of underground mining, such as block caving, might be considered.

If sufficiently large near-surface mineral deposits are found in and adjacent to the diorite-gabbro dikes and sills, an open pit method of mining could be utilized.

A mill would have to be constructed to crush and concentrate the ores from deposits on the reservation.

TRANSPORTATION AND MARKETS

Local and interstate transportation facilities are available to industries on the reservation. The Burlington-Northern railroad and two major highways provide access to major markets.

Excessive distance to markets is a negative factor for most commodities. Sand, gravel, and clay will probably be restricted to local uses. Attractive building stone from near the reservation has been sold on the Pacific Coast. A hydroponics industry should find a ready market for its year-round crops in the major western Montana and northern Idaho cities.

Ore concentrates must be shipped to smelters in this region. From geological evidence and from past production, the most important metal on the reservation is copper. Only the Anaconda Company smelter at Anaconda, Montana, and the American Smelting and Refining Company (ASARCO) smelter at Tacoma, Washington, process copper-bearing material. The Anaconda smelter will accept only concentrates. The Tacoma smelter, while preferring concentrates, will accept siliceous copper ore. Both smelters pay for copper, silver, and gold. Neither pays for platinum or palladium, and nickel is penalized.

Some of the reservation deposits may contain lead-zinc-silver resources. Ores and concentrates of these metals are accepted at the ASARCO smelter in East Helena, Montana, the Bunker Hill smelter in Kellogg, Idaho, and at the Cominco, Ltd. smelter in Trail, British Columbia, Canada.

ENVIRONMENTAL AND SOCIAL EFFECTS

Presently most tribal income comes from timber sales, rental of the Kerr Damsite, and grazing leases. Most employment is in logging and lumbering, and farming and ranching. About one-third of the reservation's potential labor force is unemployed.

For the past 20 years, there has been no mining or quarrying on the reservation except for minor sand and gravel operations. Recent geological reconnaissance programs have outlined mineralized areas in which future exploration would be warranted. The return of mining properties to the jurisdiction of the tribe may stimulate activity in this industry, and have a significant impact on the Indian labor market.

Other new industries like hydroponics and ceramics can be wholly owned, operated, and staffed by tribal members.

With proper safeguards, these industries should have no adverse affects on the environment.

RECOMMENDATIONS FOR FURTHER STUDY

Study of the reservation's metallic resources should be concentrated on the more favorable areas outlined by Montana Bureau of Mines and Geology's geochemical sampling. Additional work should include geological mapping as well as additional soil and rock sampling and geophysical traverses.

Geologic, geophysical, and geochemical studies should be conducted in all of the unmapped area shown on Figure 4 and Figure 5. The zone at the base of the Empire Formation that commonly contains potential stratabound copper deposits should be tested further. The zone should be traced geologically and sampled geochemically. Analyses of samples of stream sediments along those streams intersecting the zone should indicate areas of anomalous copper in the zone. The areas then should be tested by drilling. An inexpensive hand--held core drill can penetrate the critical 50-foot zone.

Aeromagnetic anomalies in and bordering the area indicate potential areas of buried igneous intrusives and warrant further field geologic, geophysical, and geochemical investigations. Such an anomaly, and the recommended method of study, is discussed below.

In the McCormick-Squaw Peak area, southwest of Dixon (Figure 5 and Figure 24), a large northwesterly trending positive magnetic anomaly that straddles the southern boundary of the reservation may be a result of a near surface igneous mass. The mass may be the source of the mineralized veins in the area (Figure 24). Sparse data on the veins indicate that they trend or dip toward the area of the anomaly. If they are related, the igneous mass would be late Mesozoic or Cenozoic in age--the age of the veins.

The area over the anomaly, extending from the reservation boundary north to the area east of Revais Creek, should be studied by detailed (1:24,000 scale) geologic mapping, and by gravity and geochemical traverses. Ground magnetometer traverses across the anomaly may not be too conclusive without determining the magnetic susceptibility of the bedrock in the area. The Burke Formation underlies much of the anomaly, and elsewhere to the north and west it is speckled with magnetite (Kleinkopf, Harrison, and Zartman, 1972). A gravity survey would help to identify in the subsurface high density rocks that might be related to mineralization. Geochemical studies of rocks and soils may disclose other buried veins and a mineral halo over the buried mass. Geologic studies, including mapping, may disclose surface alteration of the exposed rocks that would be indicative of a near surface buried mass.

Gold bearing gravel in Revais Creek, if present, may be under a considerable thickness of glacial deposits that were derived from a glacier that moved from northern Montana and extend upstream in Revais Creek. The thickness of the glacial deposits can be determined by drilling, resistivity, gravity, or portable seismic surveys. Geologic studies in the area may result in an estimated thickness of the till.

The hot springs at and near Camas and near Camas Prairie may have a geothermal energy potential. Field examination of the springs and their deposits will aid in determining the potential but ultimately deep drilling will be necessary to determine at depth the thermal gradient, heat source, and permeability of the rocks. A detailed gravity survey should be made to help identify and determine the extent of any subsurface geothermal reservoirs or areas of hot water.

Present data on clay deposits in the reservation indicate local clay sources for common brick and similar ceramics, and in one area for pottery clay or bonding material. Sand and gravel pits are widespread in the valleys (Figure 23). Water well data, on file with the Montana Bureau of Mines and Geology at Butte, indicate that most valleys in the reservation contain large quantities of sand and gravel. Geologic studies of the Quaternary deposits should be conducted for more favorable clay and sand and gravel deposits.

REFERENCES

Alden, W. C., 1953, Physiography and glacial geology of western Montana and adjacent areas: U.S. Geol. Survey Prof. Paper 331, 200 p.

Balster, C. A., 1971, Catalog of stratigraphic names for Montana: Montana Bur. Mines and Geol., Spec. Pub. 54, 448 p.

_____, 1971, Stratigraphic correlations for Montana and adjacent areas, 2d ed.: Montana Bur. Mines and Geol., Spec. Pub. 55, (1 sheet).

Bennett, G. N., 1943, Big Chief mine, Sanders County, Montana: U.S. Bur. Mines Montana file 21.21.

Bentley, C. B., and Mowat, G. D., 1967, Reported occurrences of selected minerals in Montana: U.S. Geol. Survey Min. Inv. Resource Map MR-50.

Berg, R. B., 1970, Current geological and geophysical studies in Montana: Montana Bur. Mines and Geol., Spec. Pub. 50, 24 p.

_____, 1971a, Current geological and geophysical studies in Montana: Montana Bur. Mines and Geol., Spec. Pub. 56, 15 p.

_____, 1971b, Index of graduate theses on Montana geology: Montana Bur. Mines and Geol., Spec. Pub. 53, 47 p.

_____,1972, Current geological and geophysical studies in Montana: Montana Bur. Mines and Geol., Spec. Pub. 58, 15 p.

_____, 1973, Current geological and geophysical studies in Montana: Montana Bur. Mines and Geol., Spec. Pub. 59, 17 p.

_____, 1974, Building stone in Montana: Montana Bur. Mines and Geol., Bull. 94, 41 p.

_____, 1974, Current geological and geophysical studies in Montana: Montana Bur. Mines and Geol., Spec. Pub. 63, 16 p.

_____, 1975, Current geological and geophysical studies in Montana: Montana Bur. Mines and Geol., Spec. Pub. 68, 15 p.

Boetcher, A. J., and McMurtrey, R. G. (in preparation), A hydrologic study of the lower Flathead River Basin, northwestern Montana: Montana Bureau of Mines.

Bondurant, K. T., and Lawson, D. C., 1969, Directory of mining enterprises for 1968 by F. V. Carrillo, W. N. Hale and M. A. McComb, U.S. Bur. Mines: Montana Bureau Mines and Geology Bull. 72, 65 p.

Bureau of Indian Affairs, 1968, The Montana--Wyoming Indian; Billings Area Office, 55 p.

Bureau of Land Management, 1974, Claim validity decision: 943.8: M 28355, 5 p.

Calkins, F. C., and MacDonald, D. F., l9O9, Geological reconnaissance in northern Idaho and northwestern Montana: U.S. Geol. Survey Bull. 384, p. 7-108.

Campbell, A. B., 1960, Geology and mineralogy deposits of the St. Regis Superior area, Mineral County, Montana: U.S. Geol. Survey Bull. 1082-I, p. 545-612.

Cannon, R. S., Jr., Pierce, A. P., Antweiler, J. C., and Buck, K. L., 1962, Lead-isotope studies in the Northern Rockies, U.S.A., in Petrologic studies. A volume in honor of A. F. Buddington: Geol. Soc. America, p. 115-131.

Chelini, J. M., Smith, R. I., and Jones, F. P., 1966, Progress report on clays and shales of Montana, 1964-1965: Montana Bur. Mines and Geol., Bull. 55, 38 p.

Chelini, J. M., Smith, R. I., and Lawson, D. C., 1965, Progress report on clays and shales of Montana, 1962-1964: Montana Bur. Mines and Geol., Bull. 45, 43 p.

Clapp, C. H., 1932, Geology of a portion of the Rocky Mountains of northwestern Montana: Montana Bur. Mines and Geol., Mem. 4, 30p.

Crosby, G. W., 1974, Preliminary study of the Hot Springs, Montana area (unpublished report).

Crosby, G. W., Hawe, R. G., and Williams, T. R., 1974, Preliminary study of the geothermal potential of the Camas Hot Springs area, Montana: Report to the Confederated Salish and Kootenai Indian Tribal Council, Univ. of Montana, 14 p.

Crowley, F. A., 1960, Directory of known mining enterprises, 1959, with list of active coal mines by Thomas Morgan: Mont. Bur. Mines and Geology Bull. 14, 64 p.

Crowley, F. A., 1961, Directory of known mining enterprises, 1960, with a section on the mineral industry of Montana: Mont. Bur. Mines and Geol. Bull. 20, 67 p.

_____,1963, Mines and mineral deposits (except fuels), Sanders County, Montana: Mont. Bur. Mines and Geol. Bull. 34, 58 p.

Daly, R. A., 1906, The nomenclature of the North American cordillera between the 47th and 53rd parallels of latitude: Geol. Jour. v. 27, p. 586-606.

Davis, W. M., 1916, The Mission Range, Montana: Geog. Rev. v. 2, no. 2, p. 267-288. , 1921, Features of glacial origin in Montana and Idaho: Assoc. Am. Geographers Annals, v. 10, p. 87-95.

Decker, G. L., 1969, Preliminary report of the geology, geochemistry, and sedimentology of Flathead Lake, northwestern Montana: M.S. thesis, Univ. of Montana.

DeMunck, V. C., and Ackerman, W. C., 1958, Barite deposits in Montana: Montana Bur. Mines and Geol., lC 22, 30 p.

Douglas, J. K., 1971, Total intensity aeromagnetic map of a portion of the Montana Lineament: Unpublished map, University of Montana, Missoula, Montana.

Douglas, J. S., 1951, Hydroponics: Oxford Univ. Press, 144 p.

Elrod, M. J., 1903, The physiography of the Flathead Lake region: Mont. State Univ. Bull. 16, p. 197-203.

Elstone, E. F., 1955, A report on the Green Mountain Mine, Revais mining district, Sanders County, Montana: Unpublished report, 6 p.

Geach, R. D., 1967, Directory of mining enterprises, 1966: Montana Bur. Mines and Geol., Bull. 58, 95 p.

_____,1968, Directory of mining enterprises for 1967 with a section on the mineral industry in Montana in 1967 by Thomas Morgan: Mont. Bur. Mines and Geol. Bull. 67, 93 p.

Gilbert, F. C., 1935, Directory of Montana mining properties: Mont. Bur. Mines and Geol. Memoir 15, 99 p.

Green Mountain project No. 1454, 1943; U.S. Bur. Mines file 21.5, Montana.

Grimshaw, R. W,, 19717 The chemistry and physics of clays and other ceramic materials: 4th Ed. Rev., John Wiley and Sons, Inc., New York, 1024 p.

Hansen, Miller, 1970, Directory of mining enterprises for 1969 with a list of active coal mines, 1969, and a section on the mineral industry of Montana in 1969 by F. V. Carrillo, W. N. Hale, and M. A. McComb, U.S. Bur. Mines and Geol. Bull. 77, 62 p.

Harrison, J. E., 1972, Precambrian Belt basin of northwestern United States: Its geometry, sedimentation, and copper occurrences: Geol. Soc. Am. Bull. v. 83, p. 1215-1240.

Harrison, J. E., Reynolds, M. W., Kleinkopf, M. D., and Pattee, E. C., 1969, Mineral resources of the Mission Mountains Primitive area, Missoula and Lake Counties, Montana: U.S. Geol. Survey Bull. 1261D, p. D48.

Harrison, J. E., and Grimes, P. J., 1970, Mineralogy and geochemistry of some Belt rocks, Montana and Idaho: U.S. Geol. Survey Bull. 1312-0, 48 p.

Harrison, J. E., Griggs, A. B., and Wells, J. D., 1974, Tectonic features of the Precambrian Belt Basin and their influence on post-Belt structures: U.S. Geol. Survey Prof. Paper 866, 15 p.

Hawe, R. G., 1975, A telluric current survey over Camas hot springs and the Marysville geothermal area, Montana, in Northwest Geology, Univ. of Montana, Missoula, v. 4, p. 26-37.

Honkala, F. S., Soward, K., and Wehrenberg, J. P., 1959, Road log, Glacial geology of the Flathead Valley and environs, in Guidebook to field trips, Rocky Mtn. section: Geol. Soc. America, 12th Ann. Mtg. Mont. State Univ., Missoula, p.25-36.

Hopkins, J. B., 1942, Glaucus mine: U.S. Bur. Mines Montana mineral property file 21.30.

Hundhausen, R. J., 1952, Glaucus copper mine, Sanders County, Montana: U.S. Bur. Mines Montana file 21.30.

Interior Board of Land Appeals, 1975, Appeal decision: IBLA 74-308, p. 30-37.

Johns, W. M., 1962, Geologic investigations in the Kootenai-Flathead area, northwest Montana, No. 4, southwestern Flathead County, Montana Bur. Mines and Geol., Bull. 29, 38 p.

_____, 1964, Geologic investigations in the Kootenai-Flathead area, northwest Montana, No. 6, southeastern Flathead County and northern Lake County: Montana Bur. Mines and Geol., Bull. 42, 66 p.

_____, 1970, Geology and mineral deposits of Lincoln and Flathead Counties, Montana: Montana Bur. Mines and Geol., Bull. 79, 182 p.

_____, 1975, Preliminary report of geochemical soil sampling, Perma Sills and Revais Dike, Perma-Dixon area, Montana: Montana Bur. Mines and Geol. unpub. rept. for the Confederated Kootenai and Salish Tribes, 8 p.

Johns, W. M., Lawson, D. C., and McClernan, H. G., 1970, Report on soil sampling results in the Chief Cliff district and adjacent areas, Lake County, Montana: Montana Bur. Mines and Geol., unpub. rept. for the Confederated Kootenai and Salish Tribes, 62 p.

Johns, W. M., and McClernan, H. G., 1969, Report on the Chief Cliff district and adjacent areas, Lake County, Montana: Montana Bur. Mines and Geol., unpub. rept. for the Confederated Kootenai and Salish Tribes, 20 p.

Johns, W. M., McClernan, H. G., and Lawson, D. C., 1971, Geological reconnaissance and soil-sample investigation of the Ravalli-DixonPerma-Camas Prairie area, Sanders County, Montana: Montana Bur. Mines and Geol., unpub. rept. for the Confederated Kootenai and Salish Tribes, 40 p.

Johns, W. M., Smith, A. G., Barnes, W. C., Gilmour, E. H., and Page, W. D., 1963, Geologic investigations in the Kootenai-Flathead area, northwest Montana, No. 5, western Flathead County and part of Lincoln County: Montana Bur. Mines and Geol., Bull. 36, 68 p.

Kleinkopf, M. D., and Mudge, M. R., 1972, Aeromagnetic, Bouguer gravity, and generalized geologic studies of the Great Falls-Mission Range area, northwestern Montana: U.S. Geol. Survey Prof. Paper 726-A, 19 p.

Kleinkopf, M. D., Harrison, J, E.? and Zartman? R. E., 1972? Aeromagnetic and geologic map of part of northwestern Montana and northern Idaho: U.S. Geol. Survey Geophys. Inv. Map GP-830.

Kleinkopf, M. D., Harrison, J. E., and Wilson, W. D., 1975, Geophysical studies in the Belt Basin, Montana: Geol. Soc. of America, Rocky Mtn. Section programs, v. 7, no. 5, p. 618.

Konizeski, A. B., and McMurtrey, R. G., 1968, Geology and groundwater resources of the Kalispell Valley, northwestern Montana: Mont. Bur. Mines and Geology Bull. 68, 42 p.

LaPoint, D. J., 1973, Gravity survey and geology of the Flathead Lake region, Montana, in Northwest Geology, Univ. of Montana, Missoula, v. 2, p. 13-20.

Larrabee, D. M., and Shride, A. F., 1946, Preliminary map showing sand and gravel deposits of Montana: U.S. Geol. Survey Missouri Basin Studies, No. 6, map (compiled).

Lawson, D. C., 1974, Directory of mining enterprises for 1973. Montana Bur. Mines and Geol., Bull. 92, 59 p.

Lickes, M. R., Nickelson, H. B., and Hosterman, J. W., 1955, Green Mountain Mine (Final Rept., amended contract, Amador Mining Co. assignee of Kootenay Copper Mines): U.S. Bur. Mines Montana Mineral Property file 21.90.

Love, W. H., 1948, Montana's platinum producer: Mining World, July 1948, p. 24-26.

Lyden, C. J., 1948, The gold placers of Montana: Montana Bur. Mines and Geol., Mem. 26, 151 p.

Mansfield, G. R., 1923, Structure of the Rocky Mountains in Idaho and northwestern Montana: Geol. Soc. Am. Bull., v. 34, p. 263-284.

McKelvey, G. E., 1968, Depositional environment of middle carbonate units of Belt Supergroup, Montana and Idaho: Am. Assoc. Pet. Geol. Bull. v. 52, no. 5, p. 858-864.

McMurtrey, R. G., Konizeski, R. L., and Brietkrietz, Alex, 1965, Geology and ground--water resources of the Missoula Basin, Montana: Mont. Bur. Mines and Geol. Bull. 47, 35 p.

Meinzer, O. E., 1916? Artesian water for irrigation in Little Bitterroot Valley: U.S. Geol. Survey Water-Supply Paper 400-B, p. 9-36.

Mertie, J. B., Jr., 1969, Economic geology of the platinum metals: U.S. Geol. Survey Prof. Paper 630, 120 p.

Mudge, M. R., 1970, Origin of the disturbed belt in northwestern Montana: Geol. Soc. Am. Bull. v. 81, p. 377-392.

Newman, R. D., 1973, Reimbursable validity investigation for Bureau of Indian Affairs involving Revais Creek and Vandenburg Lookout claims: U.S. Dept. of the Interior, Bur. of Land Management, Mineral Report, 36 p.

Noble, L. H., 1952, Glacial geology of the Mission Valley, western Montana: Ph.D. Dissert., Harvard Univ., 154 p.

Norvold, R. A., and Grubich, D., 1975, For peat's sake: The Minnesota Volunteer, Sept.-Oct., p. 64-67.

Northern Pacific Railway Company, 1959, Photo geologic interpretation map showing a portion of Flathead, Lincoln, and Sanders Counties, Montana and Bonner County, Idaho, sheet 7: E. J. Longyear Co., Minneapolis.

Obradovich, J. D., and Peterman, Z. E., 1968, Geochronology of the Belt series, Montana: Canadian Jour. of Earth Sciences, p. 737-747.

O'Connor, M. P., 1967, Stratigraphy and petrology across the Precambrian Piegan Group-Missoula Group boundary, southern Mission and Ranges of Montana: Mont. Univ. Ph.D. Dissert.

Page, W. D., 1963, Reconnaissance geology of the north quarter of the Horse Plains quadrangle, Montana: Unpubl. M.S. thesis, Univ. Colorado, 66 p.

Pardee, J. T., 1910, The glacial lake Missoula: Jour. Geology, v. 18, no. 4, p. 376-386.

_____, 1942, Unusual currents in glacial Lake Missoula: Geol. Soc. Am. Bull. v. 53, p. 1569-1599.

_____, 1950, Late Cenozoic block faulting in western Montana: Geol. Soc. Am. Bull. v. 61, p. 360-404.

Pattee, E. C., 1958, Summary report on the Goyote mine, Sanders County, Montana: U.S. Bur. Mines Montana file 21.108.

Pederson, R. J,, 1975, Determination of Ag, Cu, Ni and Pb threshold in soil samples from the Perma sills: Unpublished report? Montana Bur. Mines and Geology, 6 p.

Qamar, Anthony, 1975, Borehole temperature profile at Camas Hot Springs, Montana: Rept. to the Confederated Salish and Kootenai Indian Tribal Council, Univ. of Montana, 5 p.

Revais Creek copper property contract Idm-E162, 1952: U.S. Bur. Mines file 21.5, Montana.

Reyner, M. L., and Trauerman, C. J., 1949, Directory of Montana mining properties: Montana Bur. Mines and Geol., Mem. 31, 125 p.

Richmond, G. M., Fryxell, Roald, Neff, G. E., and Weis, P. L., 1965, The Cordilleran ice sheet of the northern Rocky Mountains and related Quaternary history of the Columbia Plateau, in Wright, H. E., and Frey, D. G., ed., The Quaternary of the United States: Princeton Univ. Press, p. 231-242.

Ross, C. P., 1963, The Belt Series in Montana: U.S. Geol. Survey Prof. Paper 346, 119 p.

Sahinen, U. M., 1936, The Revais Creek mining district, Sanders County, Montana: Montana Bur. Mines and Geol., unpub. manuscript rept., 17 p.

_____, 1957, Mines and mineral deposits, Missoula and Ravalli Counties, Montana: Montana Bur. Mines and Geol., Bull. 8, 63 p.

_____, 1962, Fluorspar deposits in Montana: Montana Bur. Mines and Geol., Bull. 28, 38 p.

Sahinen, U. M., Johns, W. M., and Lawson, D. C., 1965, Geochemical reconnaissance stream--sediment sampling in Flathead and Lincoln Counties, Montana: Montana Bur. Mines and Geol., Bull. 48, 16 p.

Sahinen, U. M., Smith, R. I., and Lawson, D. C., 1958, Progress report on clays of Montana: Montana Bur. Mines and Geol., lC 23, 41 p. , 1960, Progress report on clays and shales of Montana: Montana Bur. Mines and Geol., Bull. 13, 83 p.

Sahinen, U. M., Smith? R. I,? and Lawson, D. C., 1962, Progress report on clays and shales of Montana, 1960-1961; Montana Bur. Mines and Geol., Bull. 27? 31 p.

Sahinen, U. M., Erdmann, C. E., Weissenborn, A. E., and Weis, P. L., 1968, Geology in Mineral and water resources of Montana: Committee on Interior and Insular Affairs, U.S. Senate Document No. 98, 90th Cong., 2d Session, p. 13-22.

Sandig, R. L., 1947, General geology of mines in northwestern Montana: Unpub. B.S. thesis, Mont. School of Mines, Butte, 72 p.

Shenon, P. J., and Taylor, A. V., Jr., 1936, Geology and ore occurrence of the Hog Heaven mining district, Flathead County, Montana: Montana Bur. Mines and Geol., Mem. 17, 26 p.

Soward, K. S., 1965, Geology of damsites on Flathead River, mouth to Flathead Lake, Lake and Sanders Counties, Montana: U.S. Geol. Survey Water Supply Paper 1550, 91 p.

Stearns, N. D., Stearns, H. T., and Waring, G. A., 1937, Thermal springs in the United States: U.S. Geol. Survey Water-Supply Paper 679-B, p. 59-206.

Stout, K. S., 1954, List of known mining enterprises: Montana Bur. Mines and Geol., Inf. Circ. 5, 18 p.

Taber, J. W., 1951, Preliminary examination of Lucky Lode prospect, Sanders County, Montana: U.S. Bur. Mines Montana file 37.293.

Trauerman, C. J., and Waldron, C. R., 1940, Directory of Montana mining properties: Montana Bur. Mines and Geol., Mem. 20, 135 p.

Trauerman, C. J., and Reyner, M. L., 1950, Directory of Montana mining properties, 1949: Mont. Bur. Mines and Geol. Memoir 31, 125 p.

U.S. Geological Survey, 1969a, Aeromagnetic map of the Hubbart Reservoir Hot Springs area, Sanders, Flathead, and Lake Counties, Montana: U.S. Geol. Survey, Geophys. Inv. Map GP-687.

_____, 1969b, Aeromagnetic map of the Plains, Perma, Superior, and Tarkio quadrangles, Sanders, Mineral, and Missoula Counties, Montana: U.S. Geol. Survey Geophys. Inv. Map GP-691.

Waldron, C. R., and Earhart, R. H., 1942, Bibliography of the geology and mineral resources of Montana; Montana Bur. Mines and Geol., Mem. 21, 356 p.

Weber, W. M., 1972, Correlation of Pleistocene glaciation in the Bitterroot Range, Montana, with fluctuations of glacial Lake Missoula: Montana Bur. Mines and Geol., Mem. 42, 42 p

Weis, P. L., 1968, Barite in Mineral and water resources of Montana: Committee on Interior and Insular Affairs, U.S. Senate Document No. 98, 90th Cong., 2d Session, p. 55-56.

Wells, J. D., 1973, Stratigraphy and geochemistry of the interfingered zone, middle Belt Basin, Alberton area, Montana, in Belt Symposium, vol. 1: Univ. of Idaho, Idaho Bur. Mines and Geol., Moscow, Idaho, p. 57-60.

_____, 1974, Geologic map of the Alberton quadrangle, Missoula, Sanders, and Mineral Counties, Montana: U.S. Geol. Survey Geologic Quad. Map GQ-1157.

Wilson, R. A., 1921, Geol. of a part of the Mission Range, Montana: Ph. D. Dissertation, Univ. of Chicago.

Wood, Herbert, 1892, Flathead coal basin, Montana: Eng. Mining Jour., v. 54, no. 3, p. 57.

Woollard, G. P., and Rose, J. C., 1963, International gravity measurements: Wisconsin Univ. Geophys. and Polar Research Center, 518 p.

Young, F. M., Crowley, F. A., and Sahinen, U. M., 1962, Marketing problems of small business enterprises engaged in lead and zinc mining: Mont. Bur. Mines and Geol. Bull. 30, 58 p.

Zartman, R. E., and Stacey, J. S., 1971, Lead isotopes and mineralization ages in Belt Supergroup rocks, northwestern Montana and northern Idaho: Econ. Geol., v. 66.

Click back button (<<) on toolbar to return to text

Table 4.--Clay with commercial potential[3/]

Mont. Bur. of Mines and Geol. Sample No.	Location	Sec.	T.	R.	Bed Thickness	Lithology	Summary of Analyses
7		24	21N	21W	15 ft.	glacial lake clay	Poor ceramic material--possibly a blending or bonding material
8		27	19N	21W		glacial lake clay	Not suitable for ceramics or aggregates. Use as low-firing bonding clay.
12		23	22N	24W		glacial lake clay	Suitable for pottery clay or a bonding material
161		4	18N	21W	8 ft.		Suitable for brick and lightweight aggregates
289		15	21N	20W		glacial lake clay	Suitable for common brick[1/]
364	NE1/4	28	23N	19W	6 ft.	silty lake clay	Suitable for common brick and similar ceramics[1/]
365	W1/2	23	17N	20W	10 ft.	glacial lake clay	Suitable for common brick and similar ceramics[1/]
383	SE1/4	23	20N	20W		illitic kaolinitic clay	For grog in common brick and similar ceramics[2/]
434	SE cor	23	22N	21W	5 ft. auger hole	silty illitic clay	With care--suitable for brick
435	SW cor	25	22N	21W	---do-----	---do-----	Do.
436	SW cor	36	22N	21W	---do-----	---do-----	Do.
437	E1/4 cor	5	21N	20W	---do-----	---do-----	Do.
438	NE cor	3	21N	20W	---do-----	---do-----	Do.
439	N1/4 cor	5	20N	20W	---do-----	---do-----	Do.
440	N1/4 cor	6	20N	20W	---do-----	---do-----	Do.
441	SW cor	31	20N	20W	---do-----	---do-----	Do.
442	C	2	20N	20W	---do-----	---do-----	Do.
443	NW1/4	6	20N	21W	---do-----	---do-----	Do.
447	E1/4 cor	26	19N	21W	---do-----	---do-----	Do.
448	SW cor	28	19N	20W	---do-----	---do-----	Do.
449	SW cor	22	19N	20W	---do-----	---do-----	Do.
452	SW1/4 SE1/4	18	18N	21W	---do-----	---do-----	Do.
453	NW cor	9	22N	20W	---do-----	---do-----	Do.
454	SW cor	29	23N	20W	---do-----	---do-----	Do.
455	S1/4 cor	2	23N	21W	---do-----	---do-----	Do.
456	W1/4 cor	31	23N	21W	---do-----	---do-----	Do.
457	SW cor	6	22N	21W	---do-----	---do-----	Do.
461	NE cor	19	24N	23W	---do-----	---do-----	Do.

[1/] With careful handling, blending, or mixing could be used for manufacture of common brick and similar ceramic products.

[2/] Blended for a more plastic clay, the material would be suitable for grog in manufacture of common brick and similar ceramic products.

[3/] References for locality description and analyses:
Samples 7-12.-Sahinen, Smith, and Lawson, 1958
Sample 289.-Sahinen, Smith, and Lawson, 1962
Samples 364-365.-Chelini, Smith, and Lawson, 1965
Samples 434-461.-Chelini, Smith, and Jones, 1966.

Click back button (<<) on toolbar to return to text

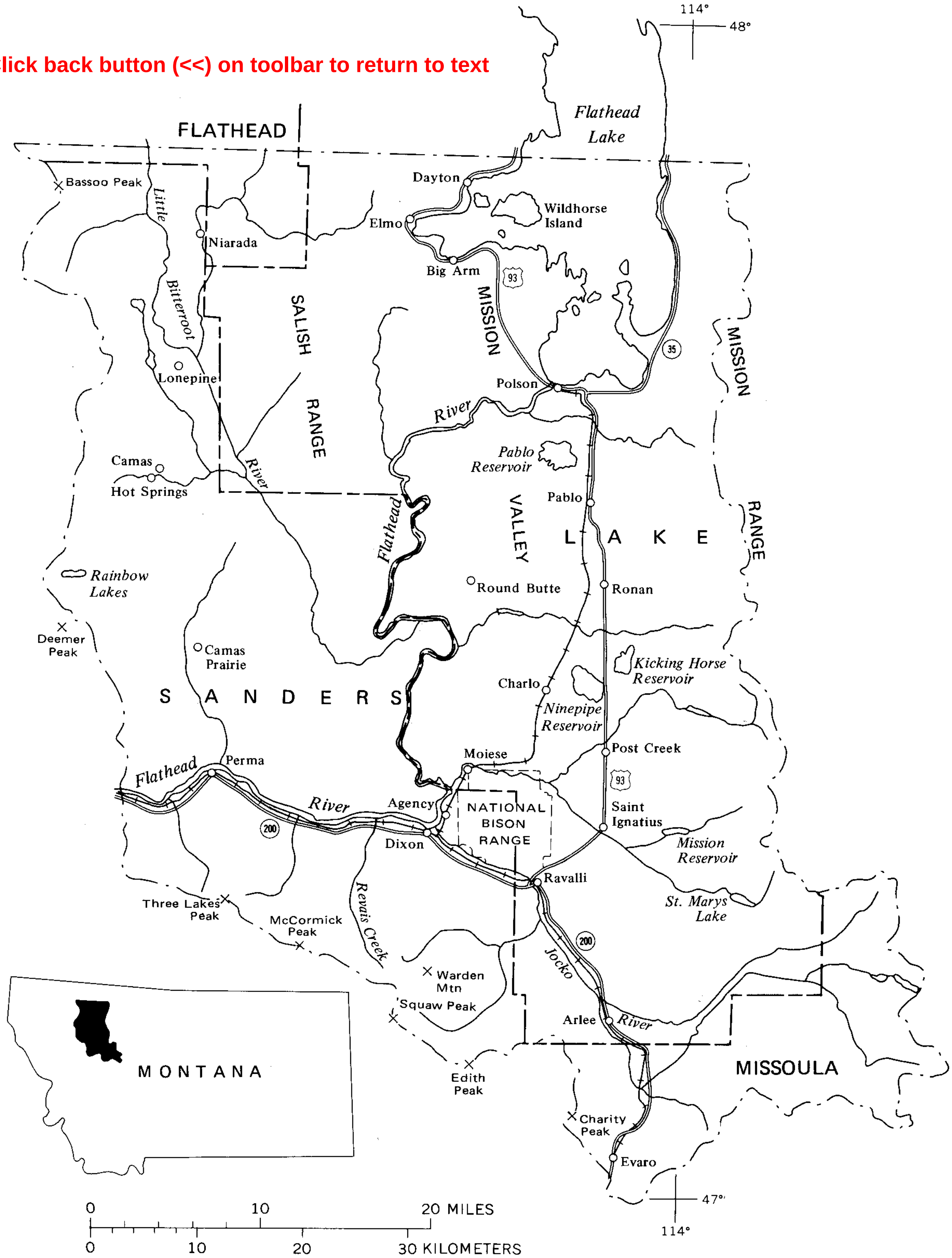


Figure 1. Index map of Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

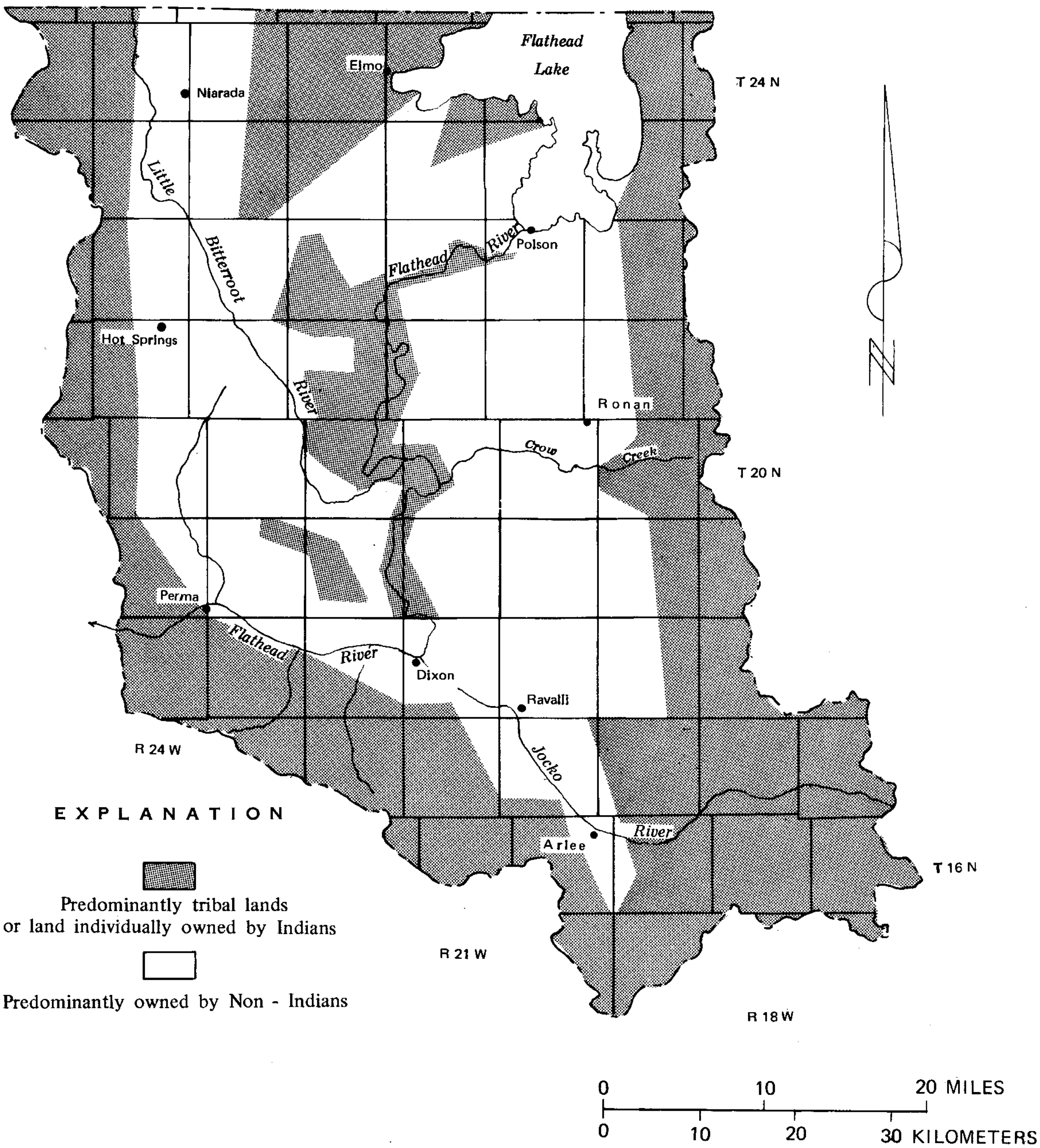


Figure 2. Map showing generalized land ownership, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

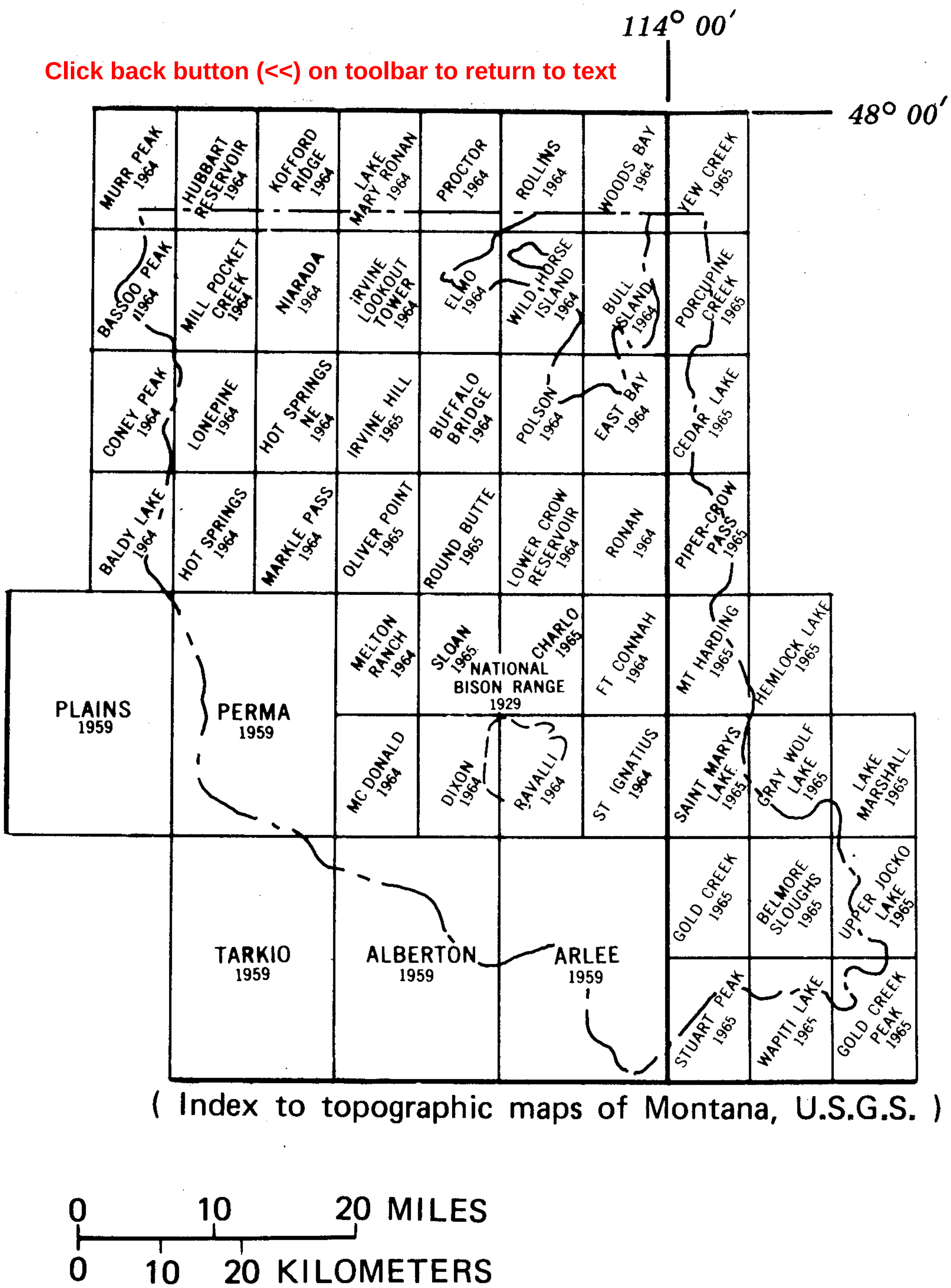


Figure 3. Index to topographic maps, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

Figure 4. Geologic map of Flathead Indian Reservation, Montana (compiled by J.E. Harrison, USGS).

Click back button (<<) on toolbar to return to text

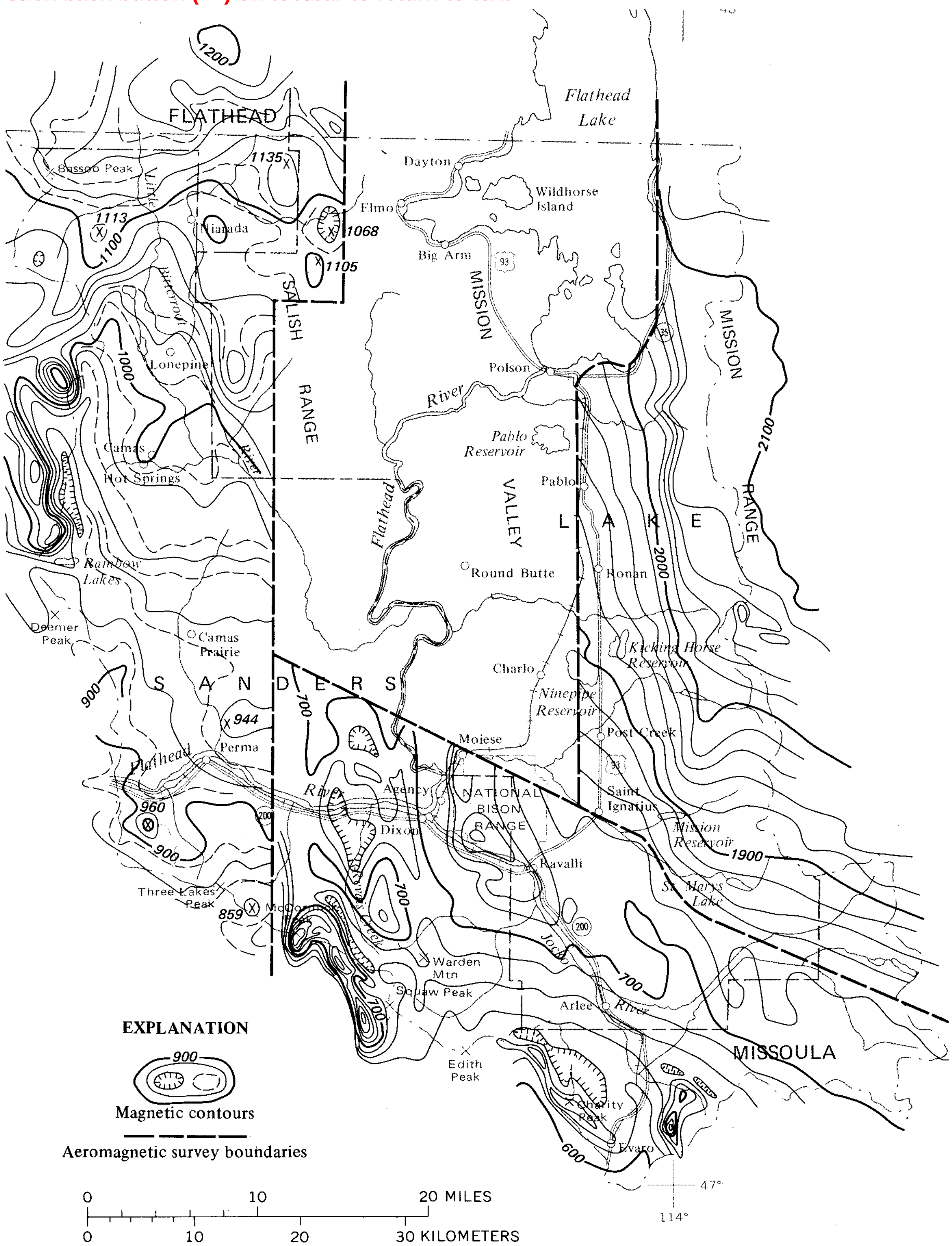


Figure 5. Total intensity aeromagnetic map of part of the Flathead Indian Reservation. The magnetic contours show the total intensity magnetic field of the earth in gammas relative to arbitrary datum. Hachured to indicate closed areas of lower magnetic intensity. Contour interval 10 and 20 gammas (see text for sources).

Click back button (<<) on toolbar to return to text

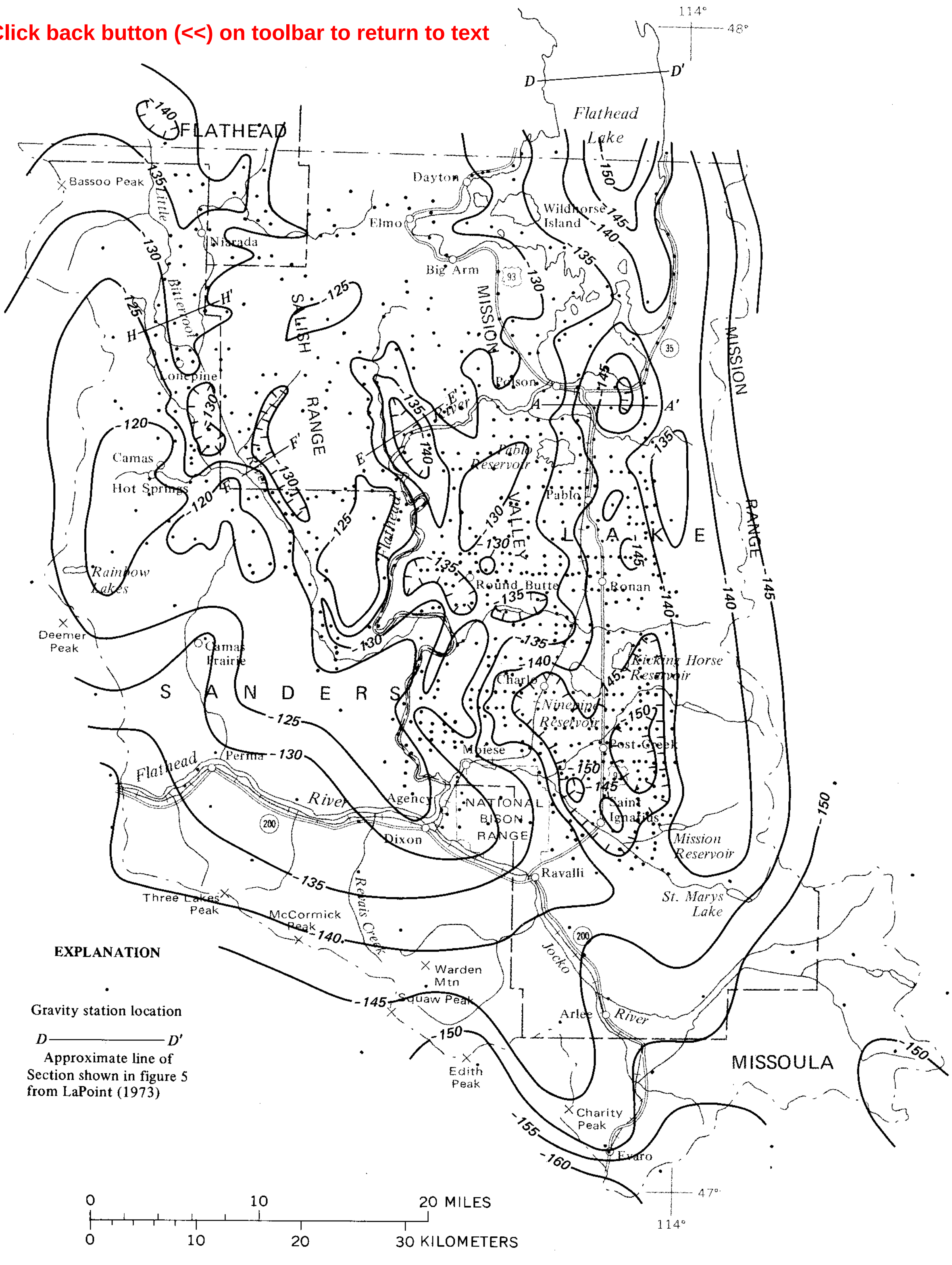


Figure 6. Gravity map of the Flathead Indian Reservation, northwestern Montana. Hachured contours enclose areas of low gravity. Contour interval 5 milligals (see text for sources).

Click back button (<<) on toolbar to return to text

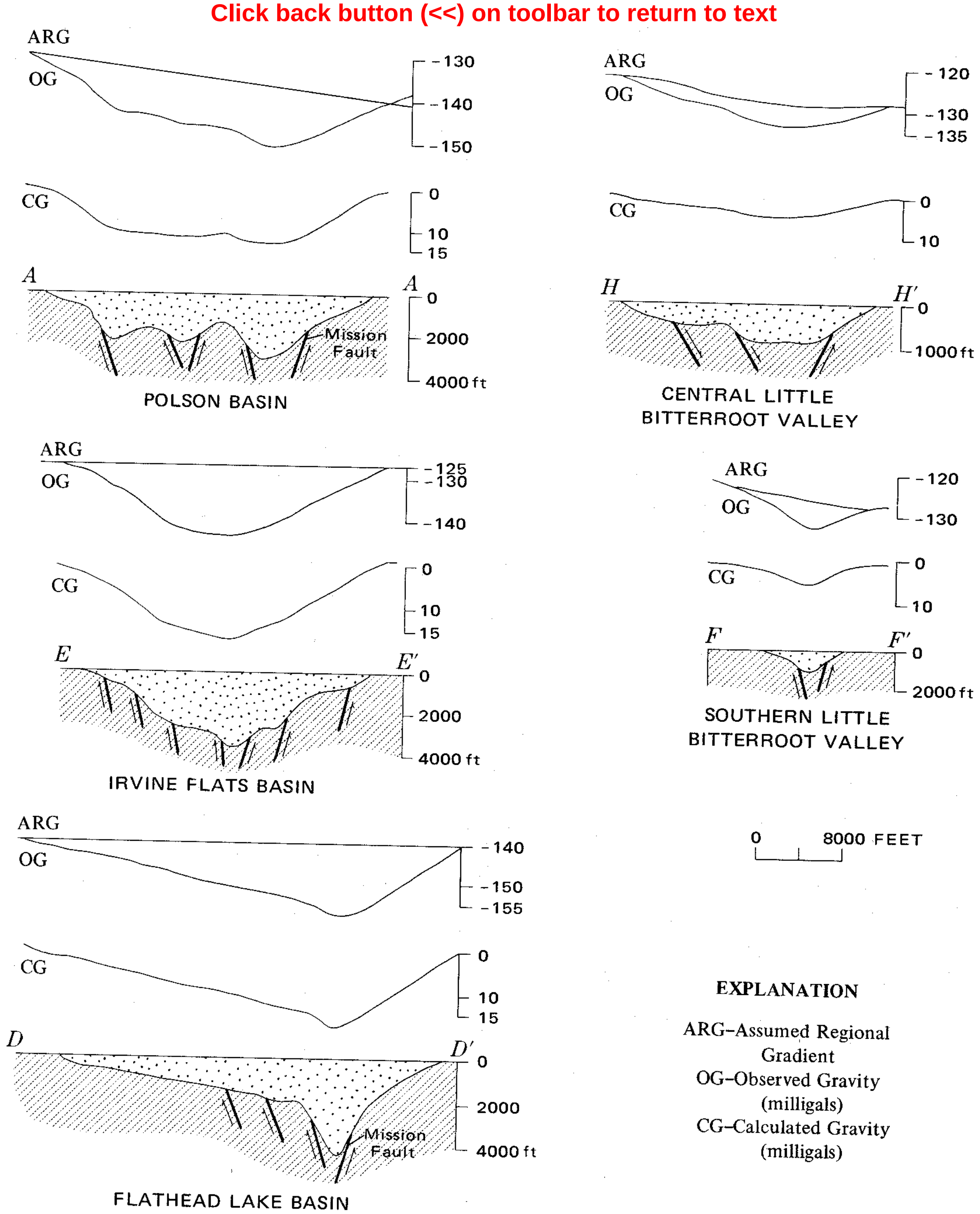


Figure 7. Gravity cross sections of valleys in the Flathead Indian Reservation (from LaPoint, 1973). Line of sections shown on Figure 7.

Click back button (<<) on toolbar to return to text

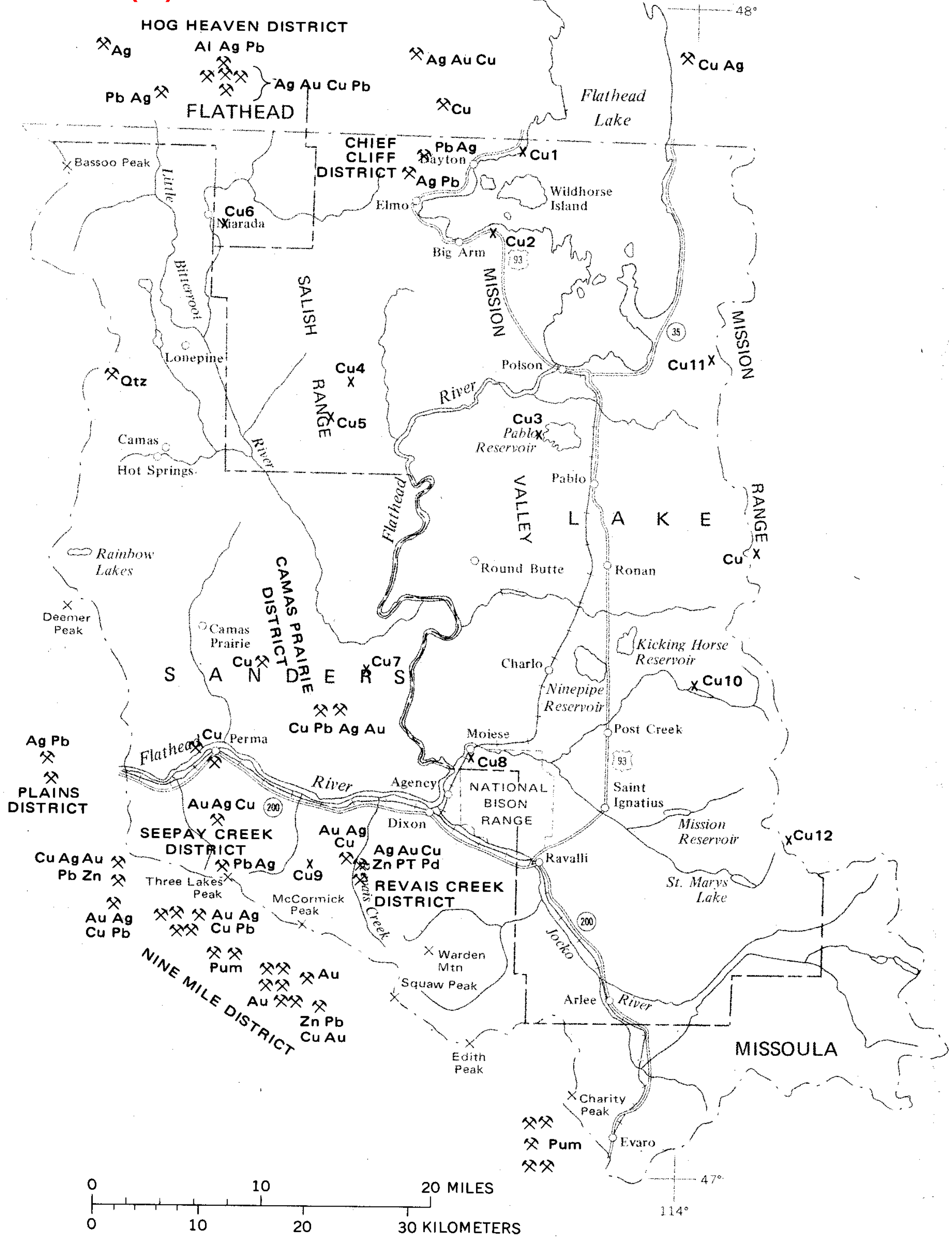


Figure 8. Map showing distribution of metallic mineral resources, Flathead Indian Reservation, northwestern Montana.

EXPLANATION

⚒ - mine or prospect

Cu,	copper
Pb,	lead
Zn,	zinc
Au,	gold
Ag,	silver
Pt,	platinum
Pd,	paladium
Pum,	pumice

x - sampled outcrop (from unpublished data of J. E. Harrison, U.S. Geological Survey)

Formation	Locality
Helena	12
Empire	3, 5
Spokane	1, 2, 10, 11
Revett	8
Burke	4, 6, 7, 9

Data from: Bondurant and Lawson, 1969; Crowley, 1960, 1961, 1963; DeMunck and Ackerman, 1958; Geach, 1968; Gilbert, 1935; Hanson, 1970; McMurtrey, Konizeski, and Brietkrietz, 1965; Johns, and others, 1963; Johns, 1964; Sahinen, 1957; Sahinen, Smith, and Lawson, 1958; Trauerman and Reyner, 1950; and Young, Crowley, and Sahinen, 1962.

Click back button (<<) on toolbar to return to text

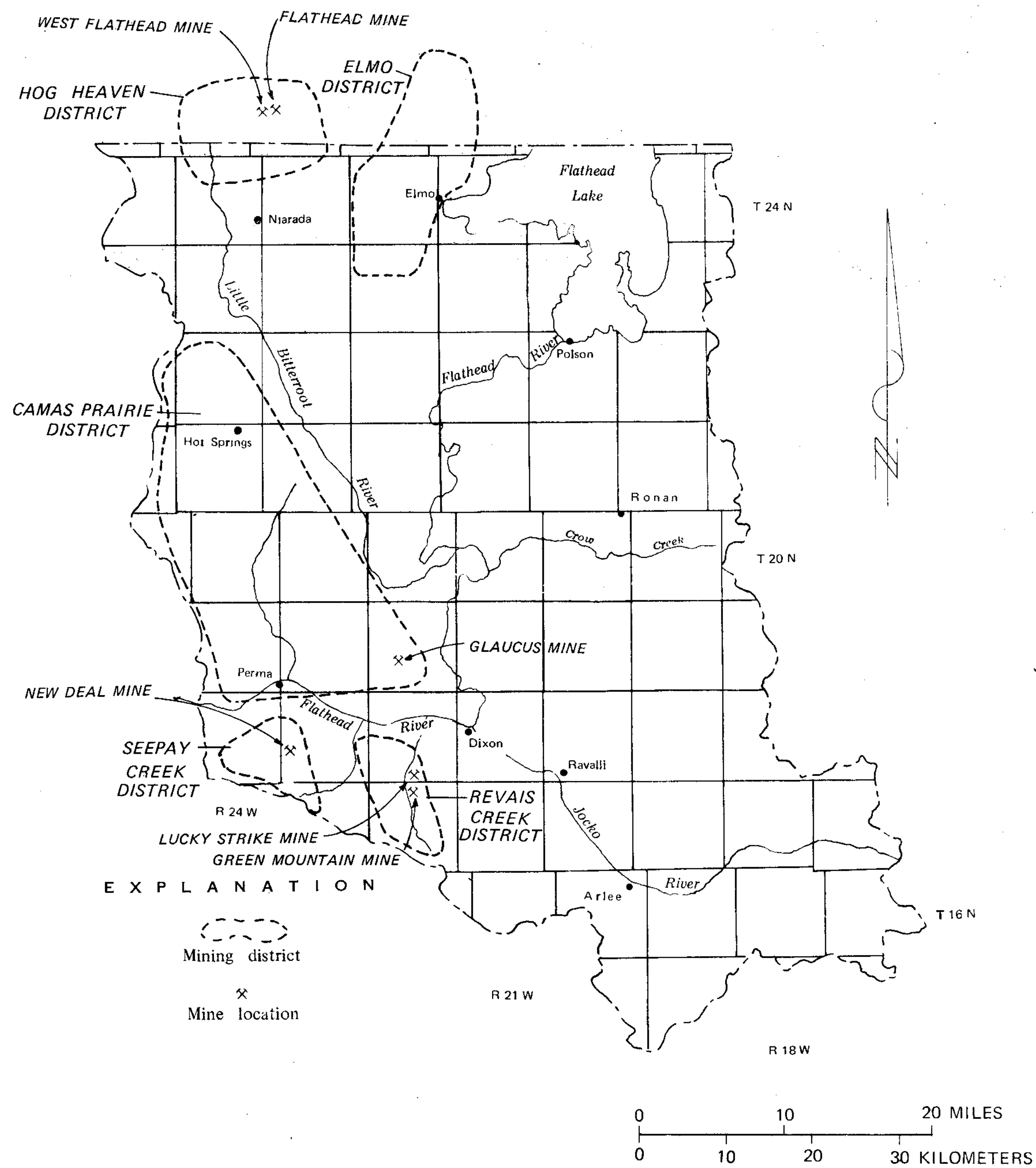


Figure 9. Map showing mining districts and mines, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

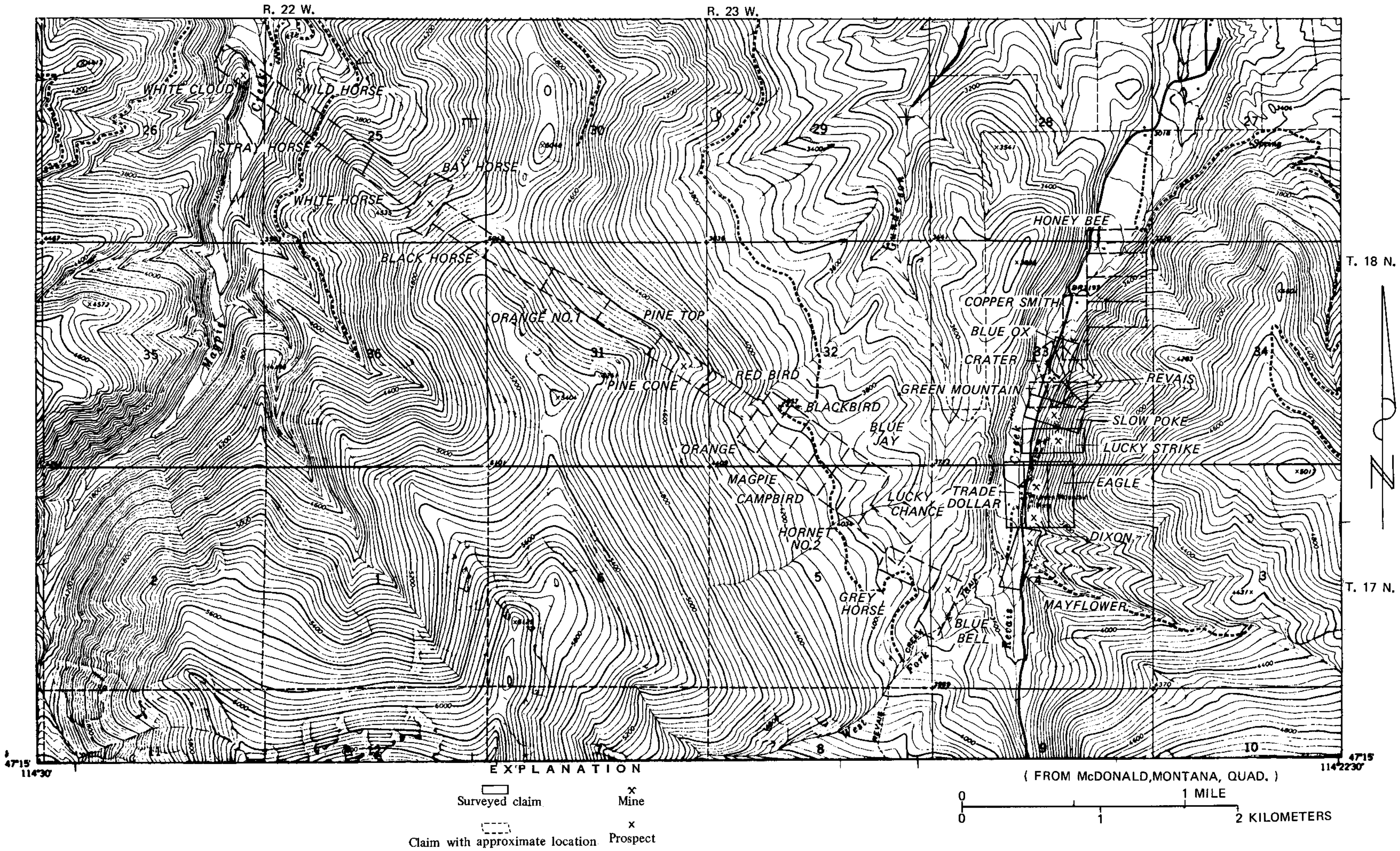


Figure 10. Map showing Revais Creek mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

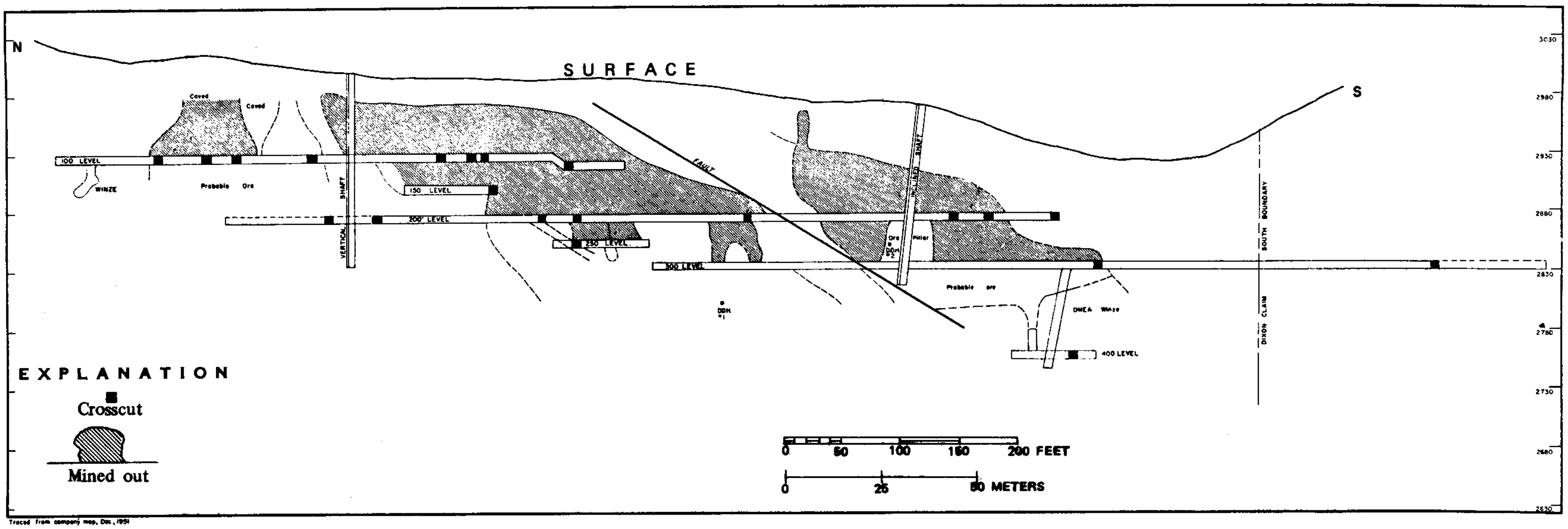


Figure 11. Longitudinal section, Green Mountain mine, Revais Creek mining district, Camas Prairie mining district, Flathead Indian Reservation, Montana (see text for source).

Click back button (<<) on toolbar to return to text

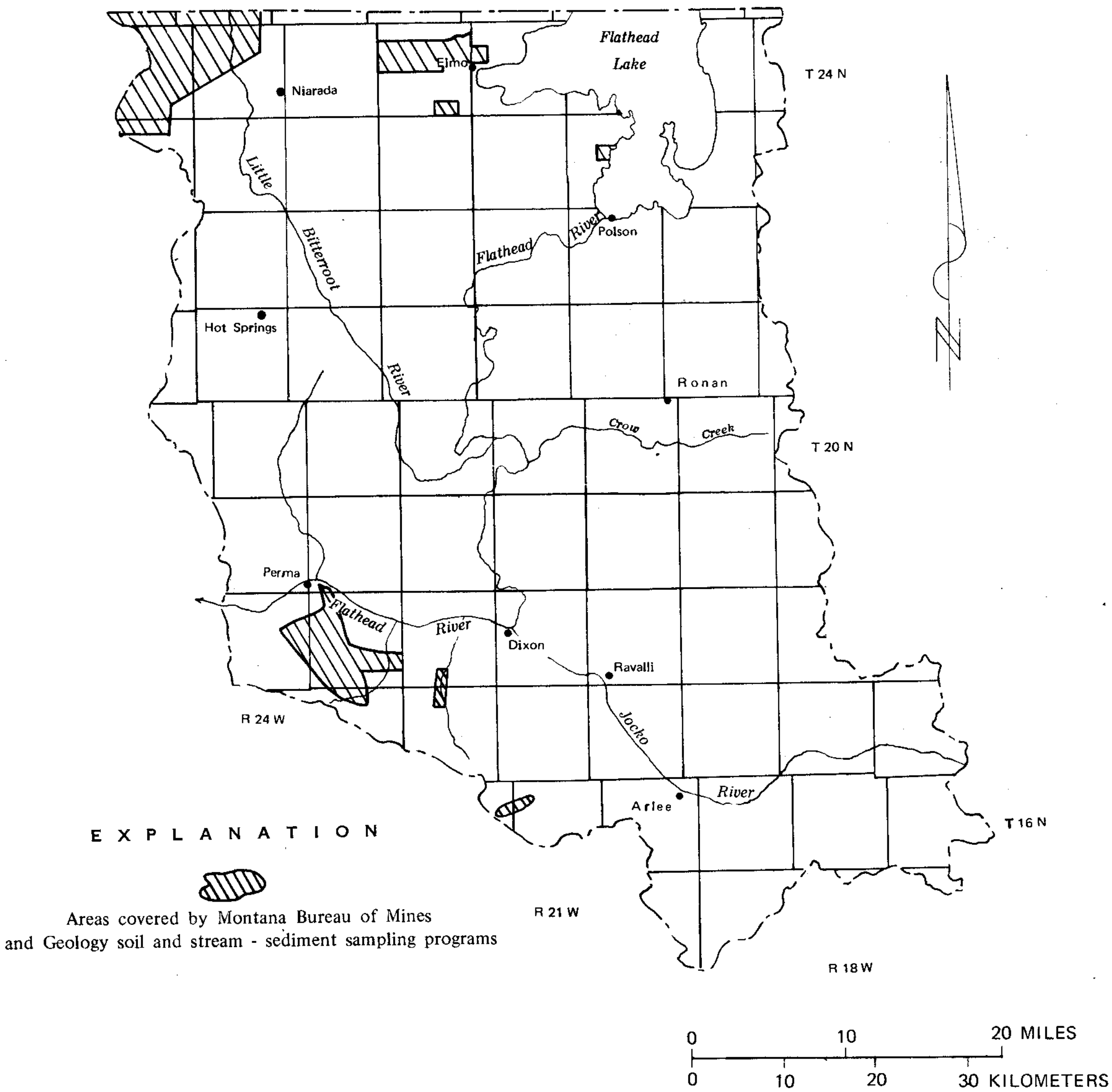


Figure 12. Map showing areas of geochemical prospecting, Flathead Indian Reservation, Montana (see text for source).

Click back button (<<) on toolbar to return to text

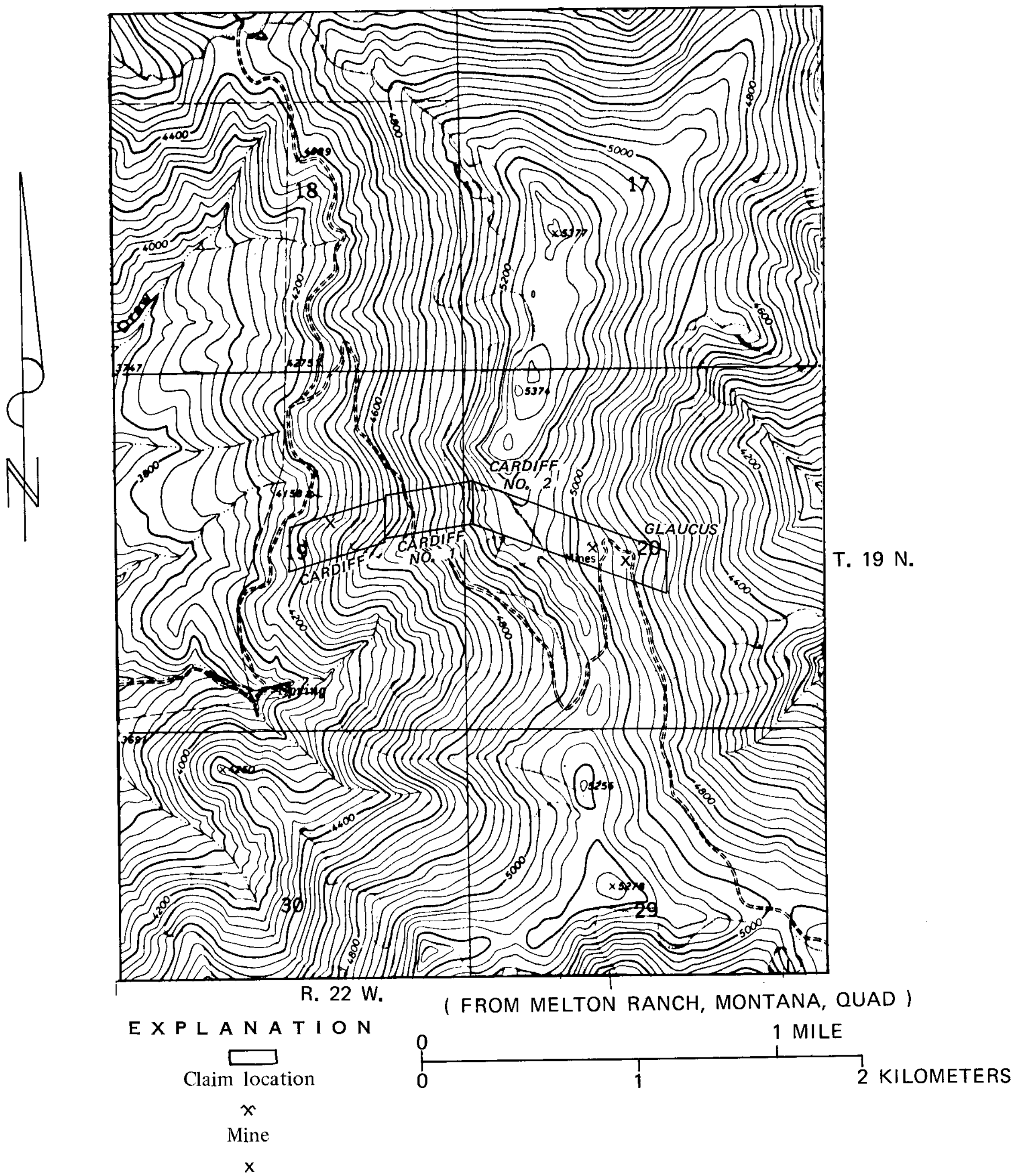


Figure 13. Map showing patented claims in the Camas Prairie mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

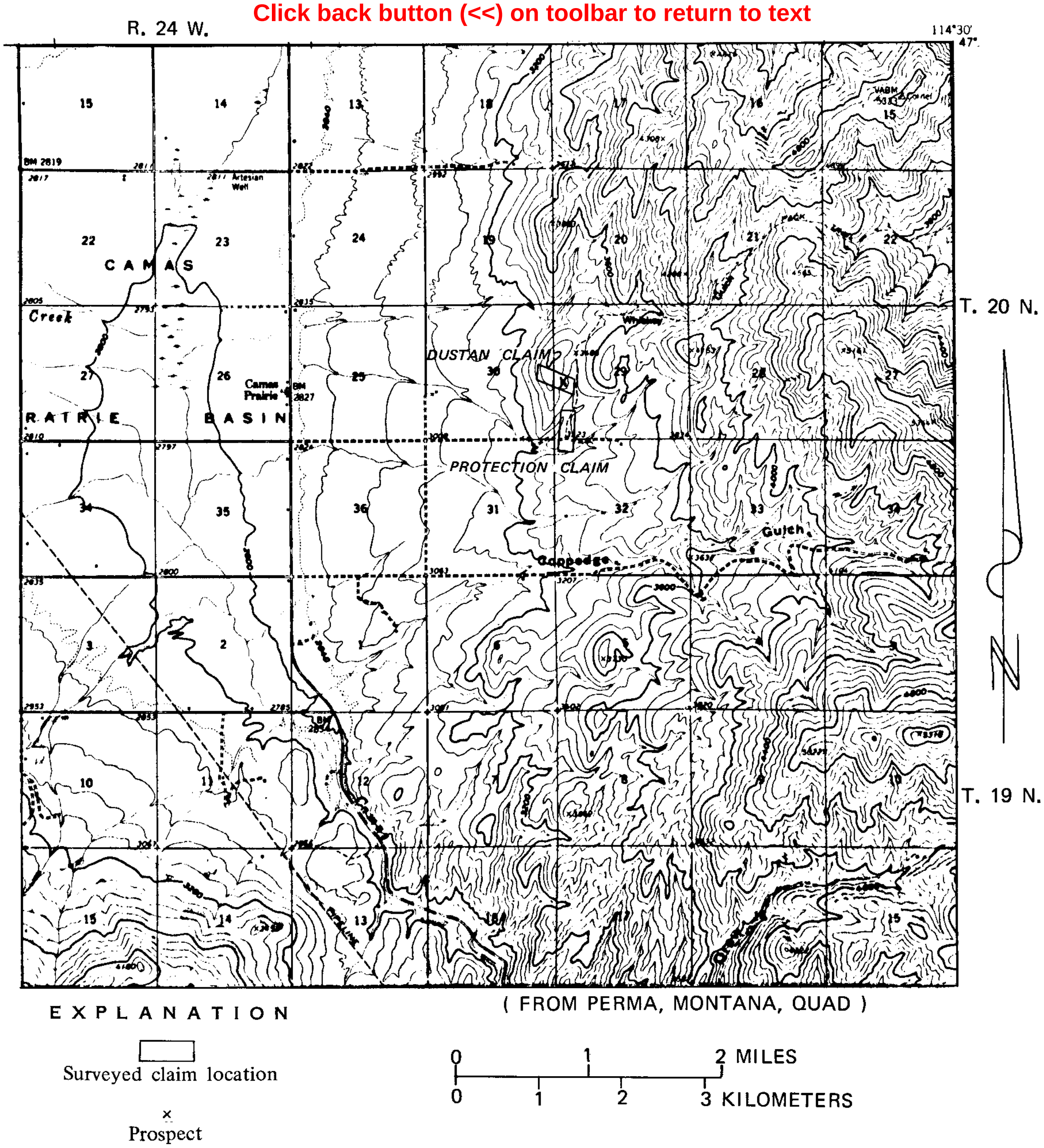
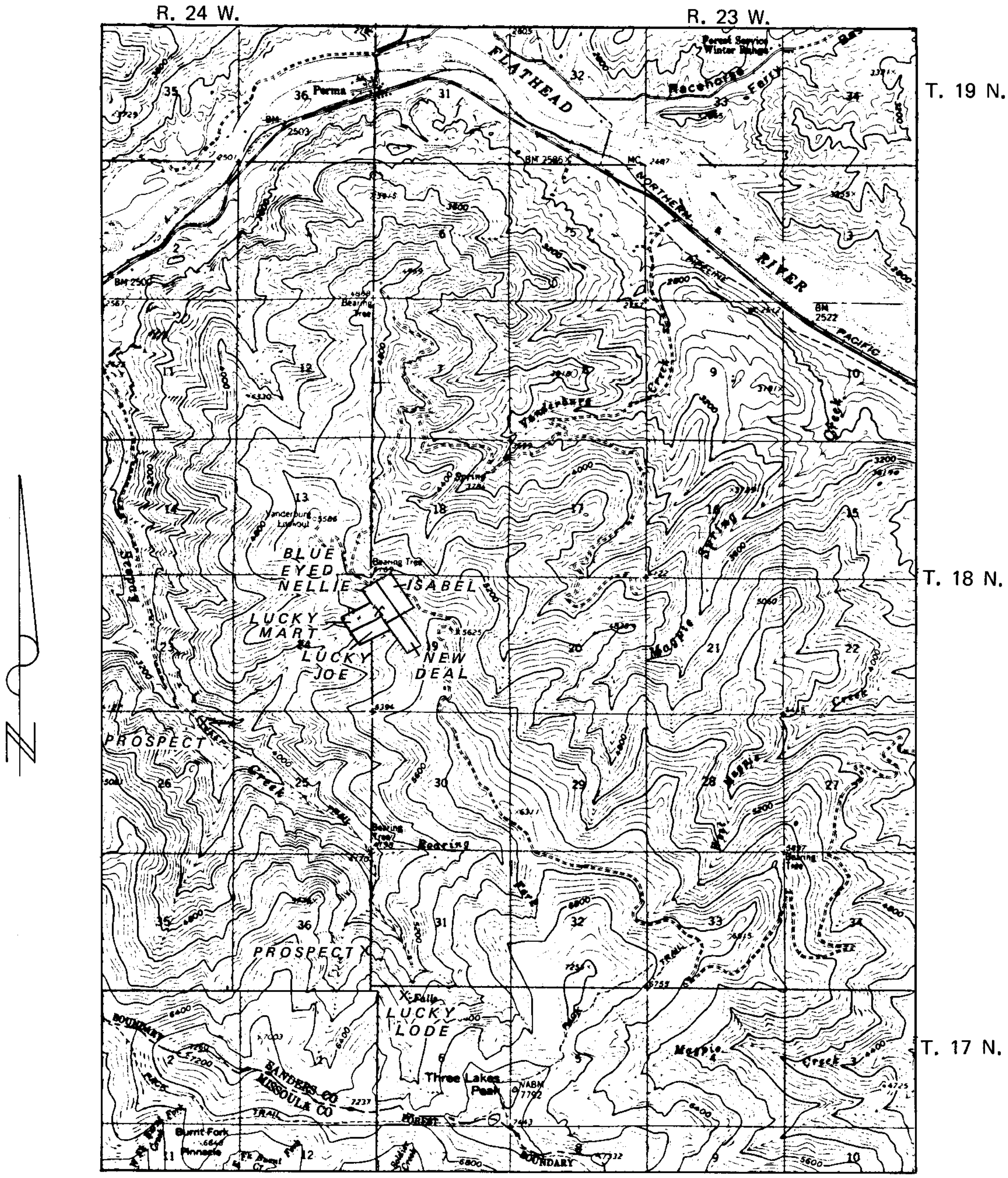


Figure 14. Map showing claims and prospects in the central part of the Camas Prairie mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text



EXPLANATION

Surveyed claim or claim with established corners

Mine

Prospect

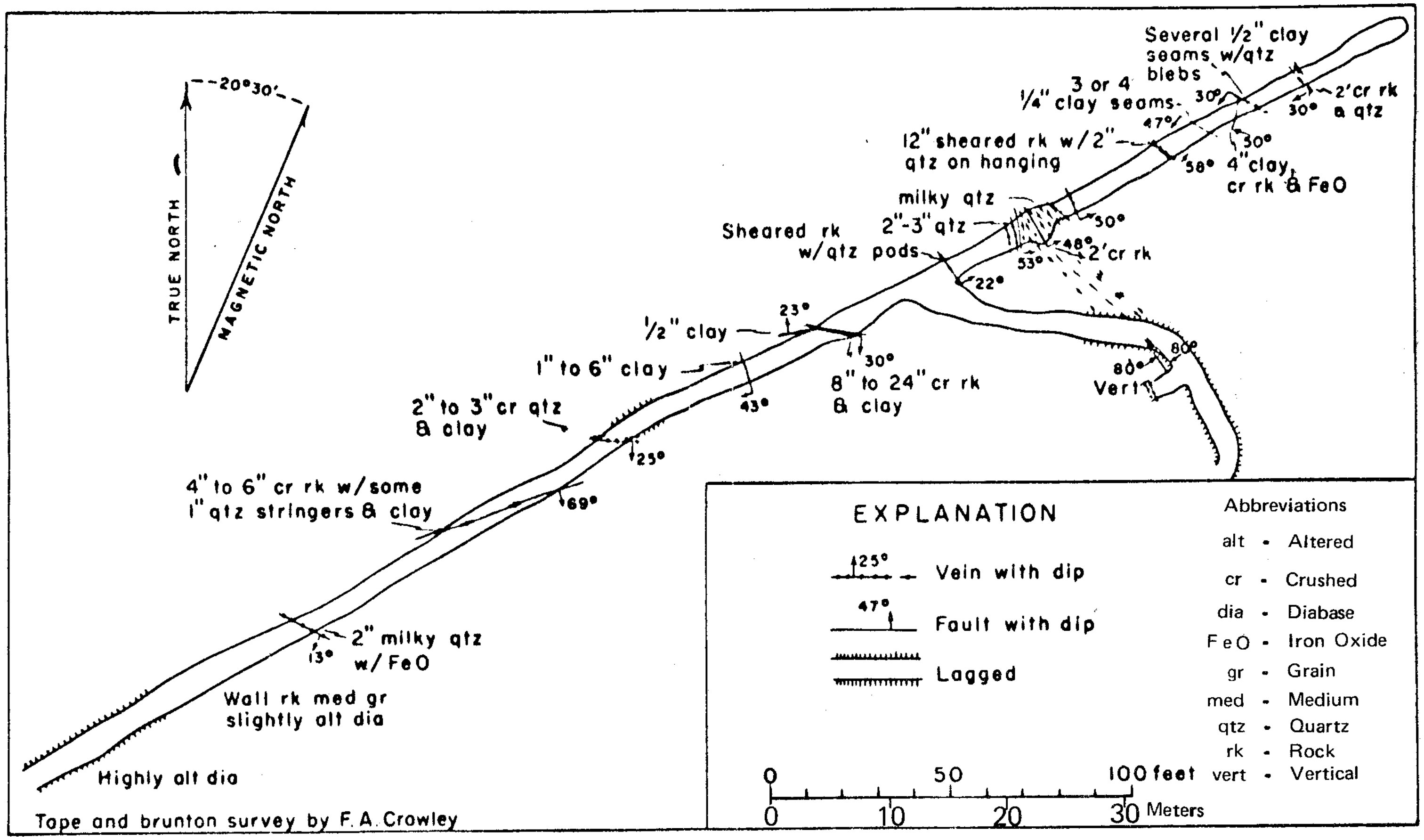
(FROM PERMA, MONTANA, QUAD)

0 1 2 MILES

0 1 2 3 KILOMETERS

Figure 15. Map showing claims and prospects in Seepay Creek mining district, Flathead Indian Reservation, Montana.

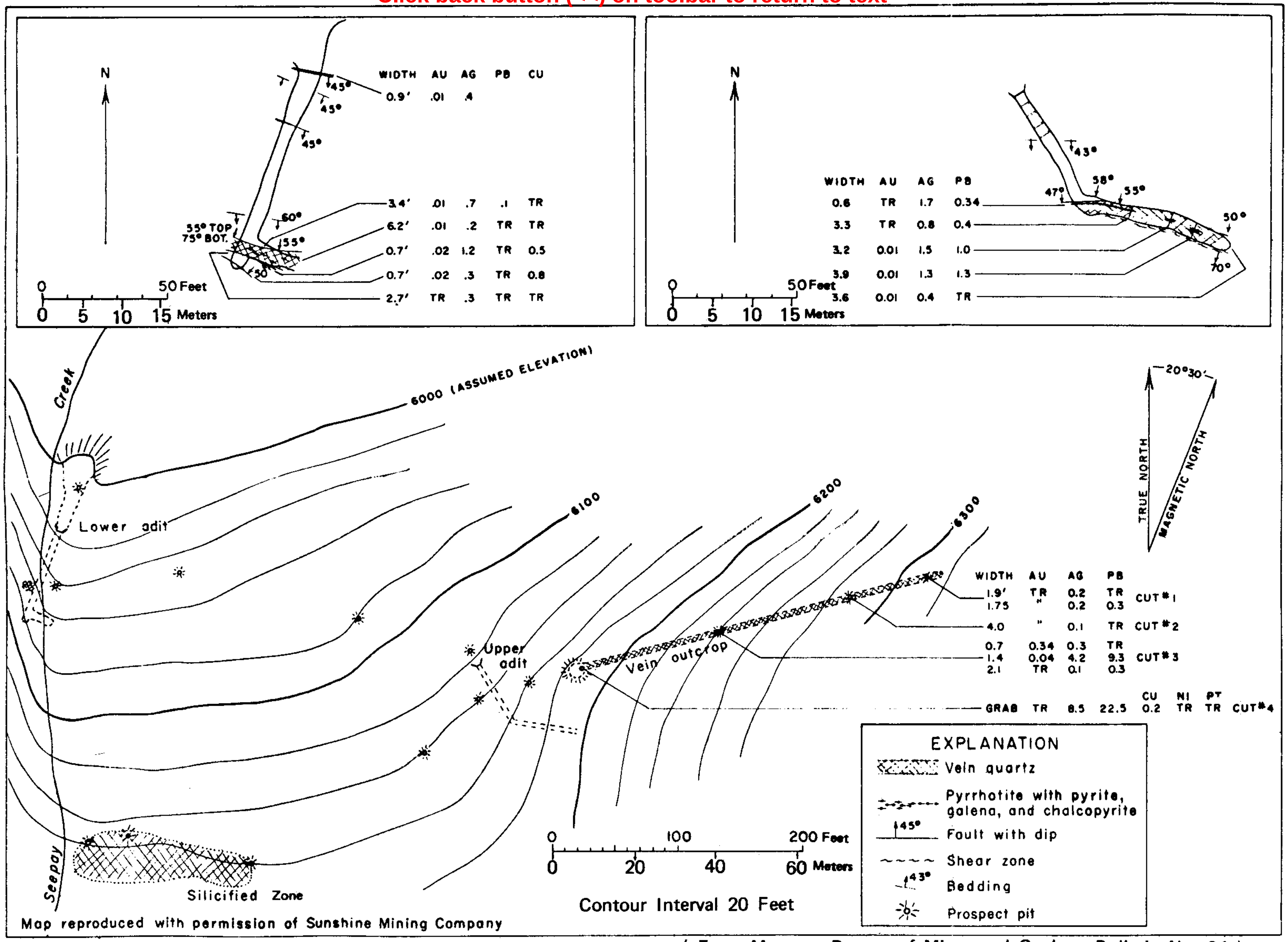
Click back button (<<) on toolbar to return to text



(From Montana Bureau of Mines and Geology Bulletin No. 34, 1963)

Figure 16. Map of New Deal adit, Seepay Creek mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text



(From Montana Bureau of Mines and Geology Bulletin No. 34)

Figure 17. Map of Lucky Lode mine, Seepay Creek mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

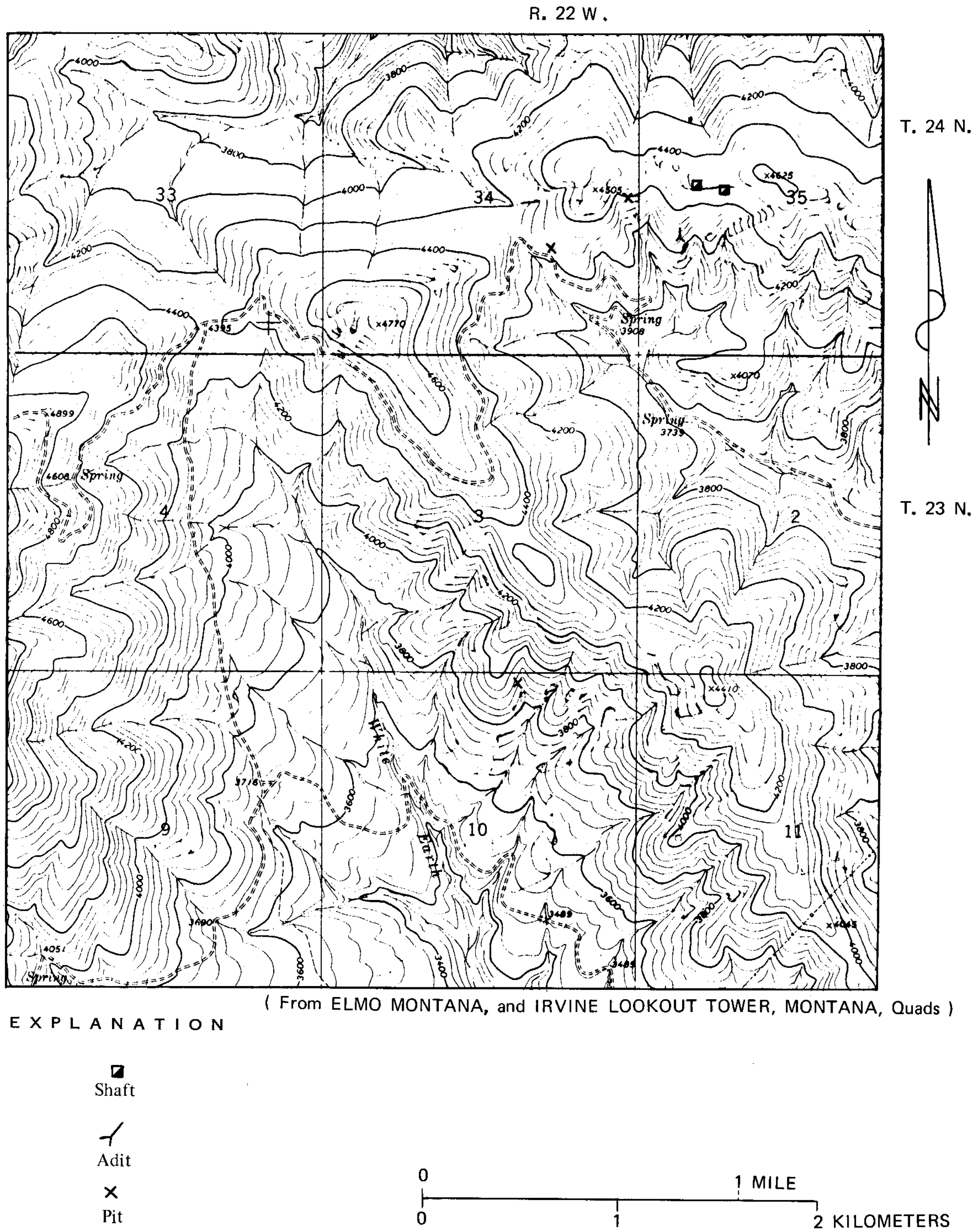


Figure 18. Map showing prospects in the southern part of the Elmo mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

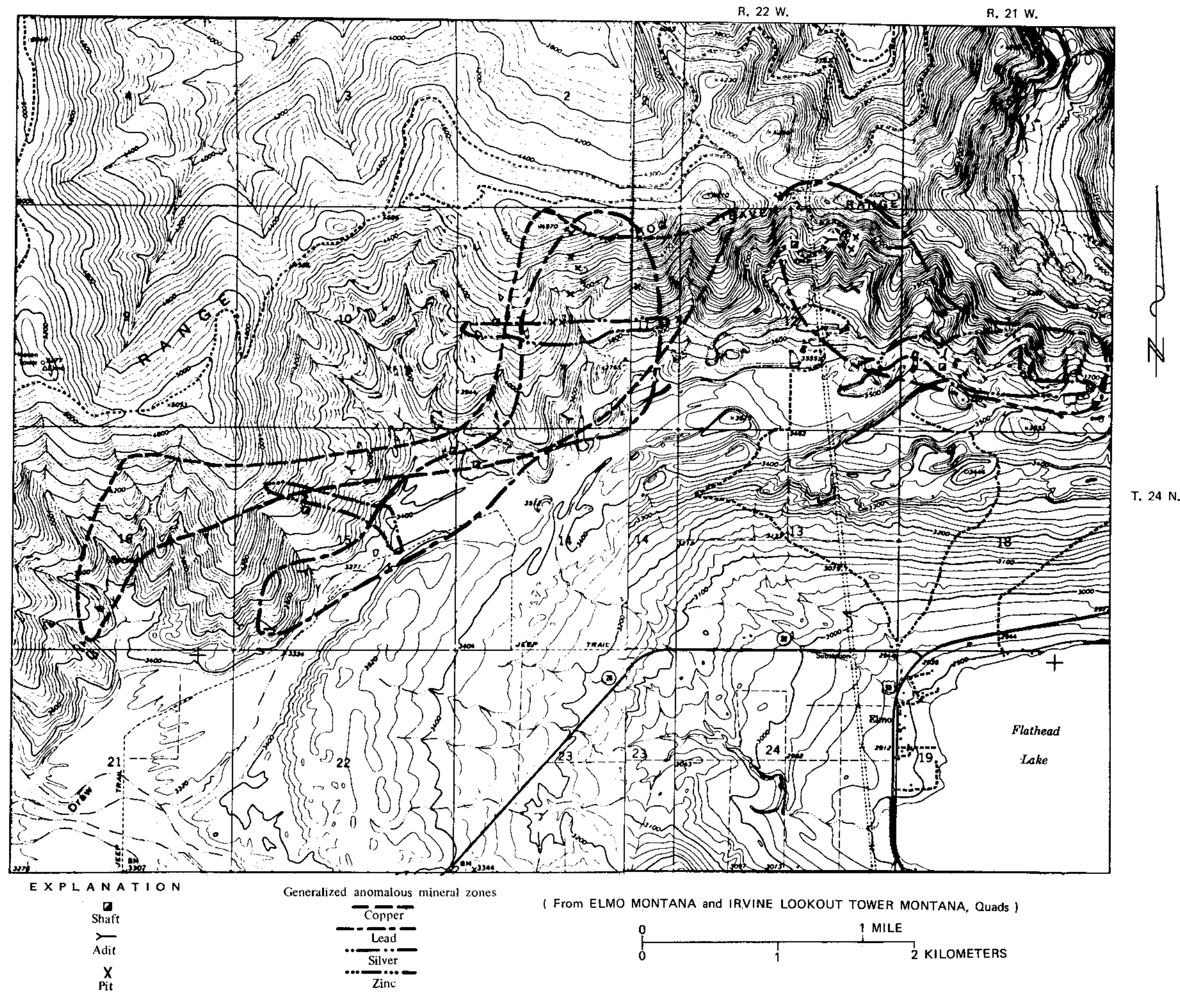


Figure 19. Map showing prospects and geochemical anomalies in the central part of the Elmo mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

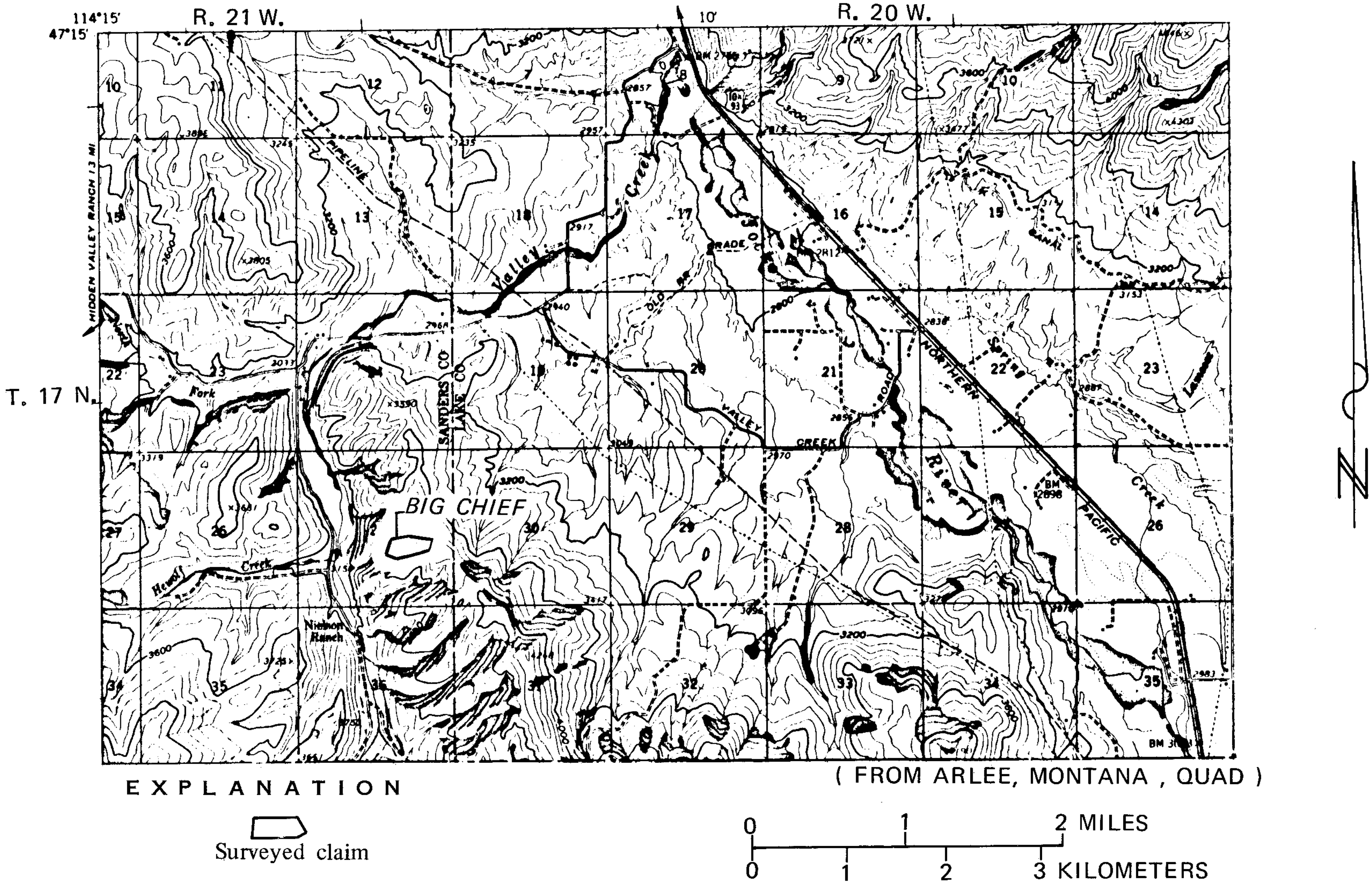


Figure 20. Map showing Big Chief claim, unorganized mining district, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

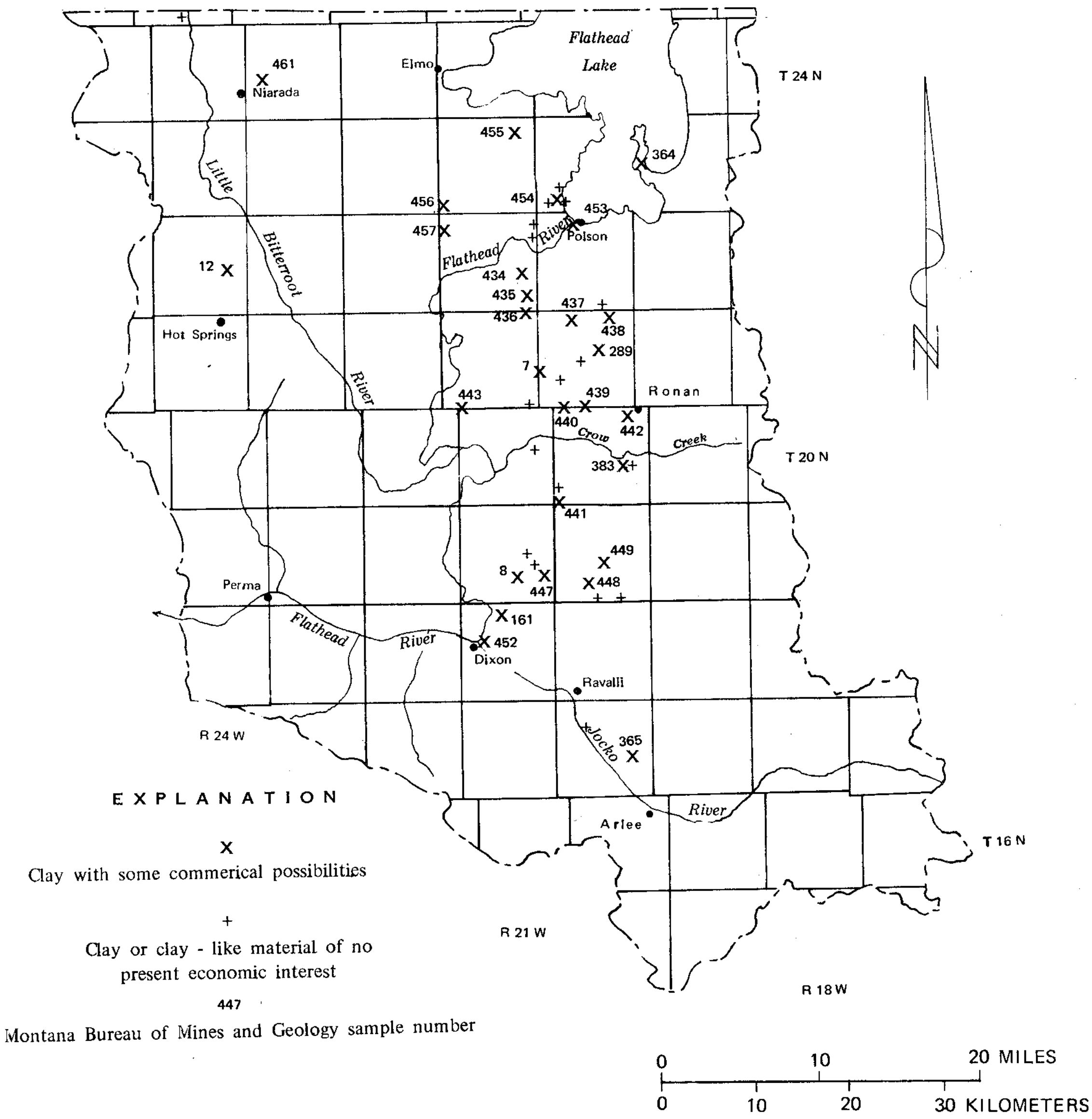


Figure 21. Map showing clay sampling locations, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

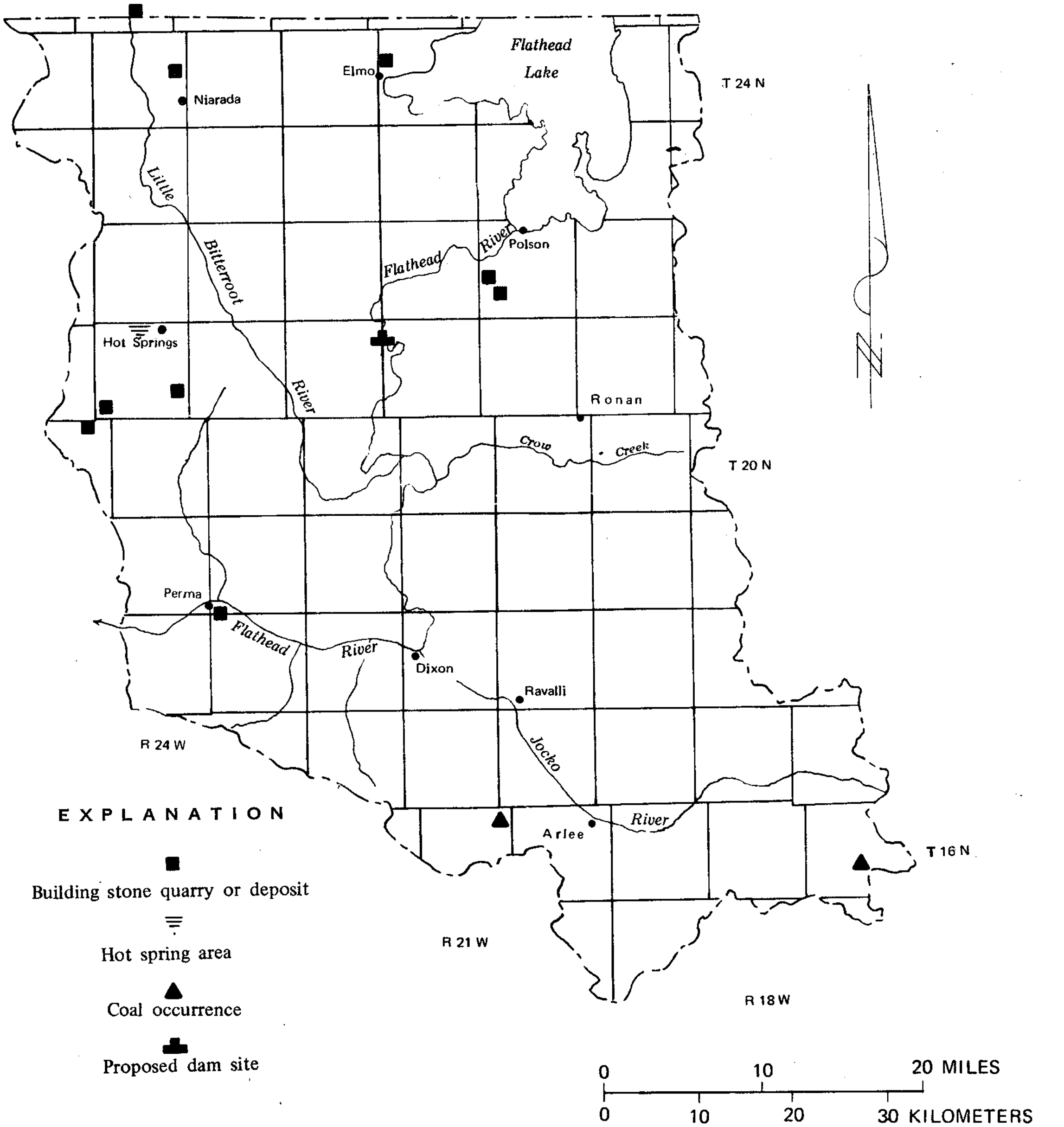


Figure 22. Map showing locations of building stone, coal, hot springs, and proposed dam site, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

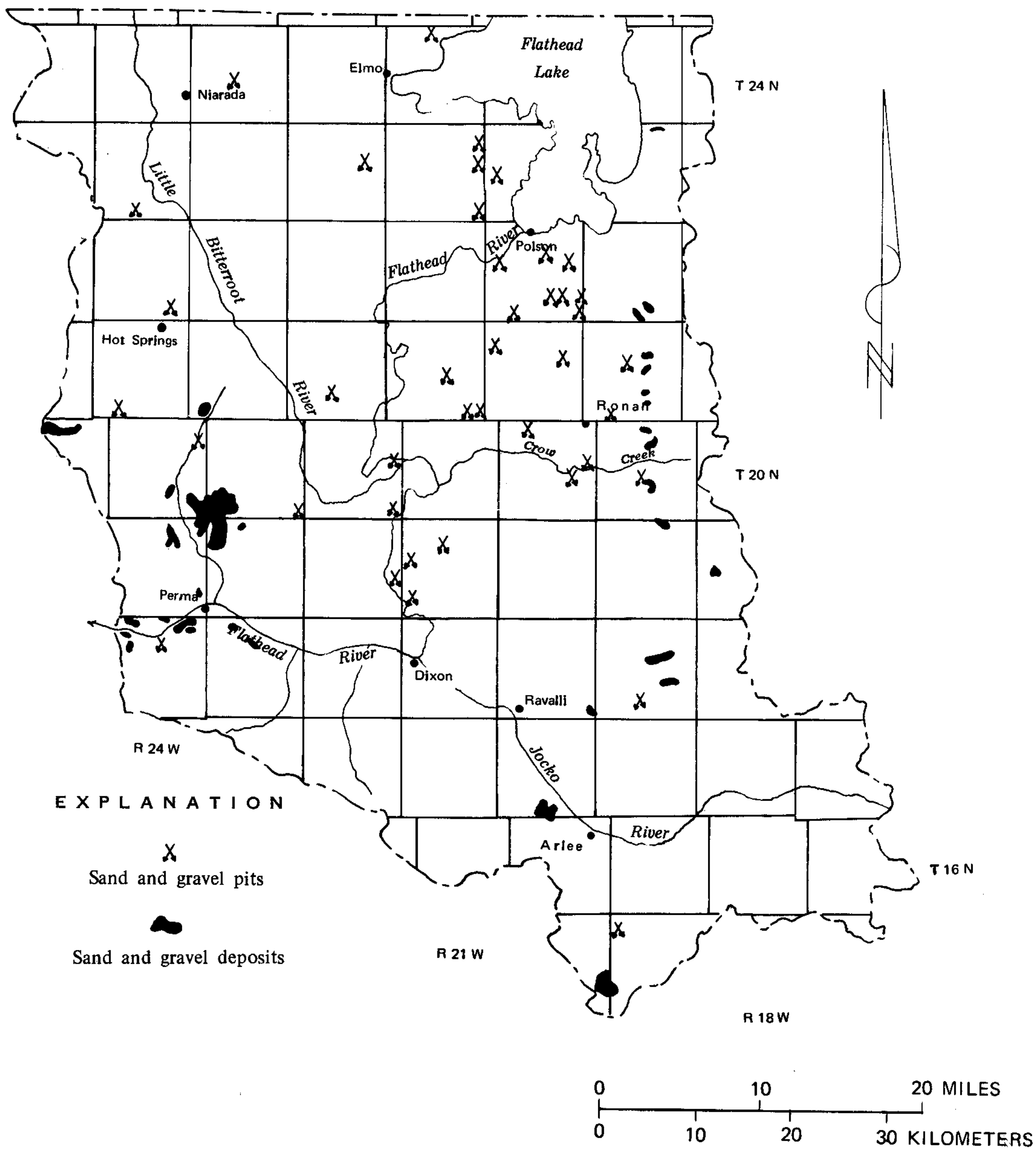


Figure 23. Map showing locations of sand and gravel occurrences, Flathead Indian Reservation, Montana.

Click back button (<<) on toolbar to return to text

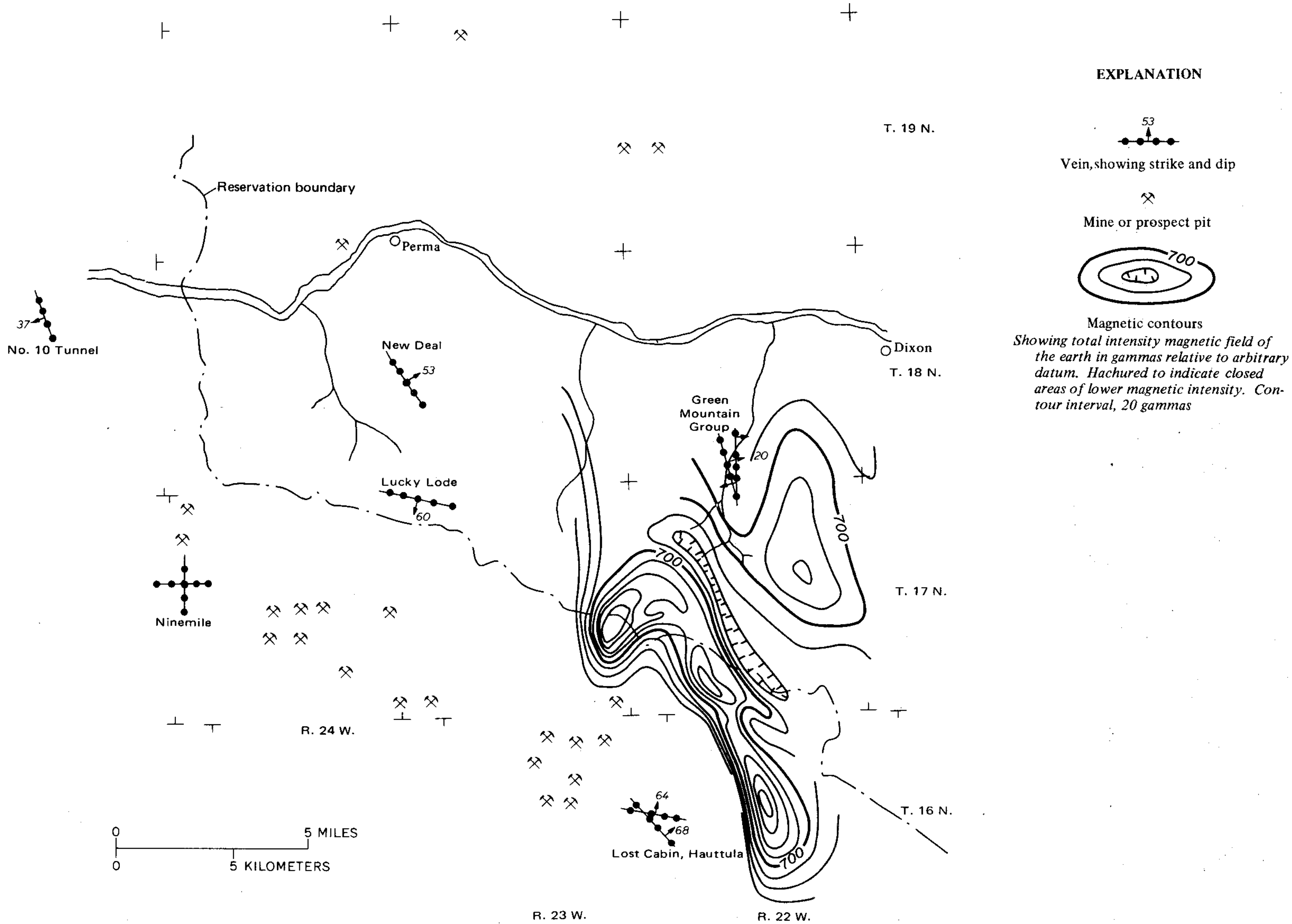


Figure 24. Map showing position of magnetic anomaly in relationship to mines and prospects, and veins in southwestern part of Flathead Indian Reservation. Mine and vein data from Sahinen (1957) and Crowley (1963). Names of mines given only where data on vein strike and dip are available.